PUBLICATIONS

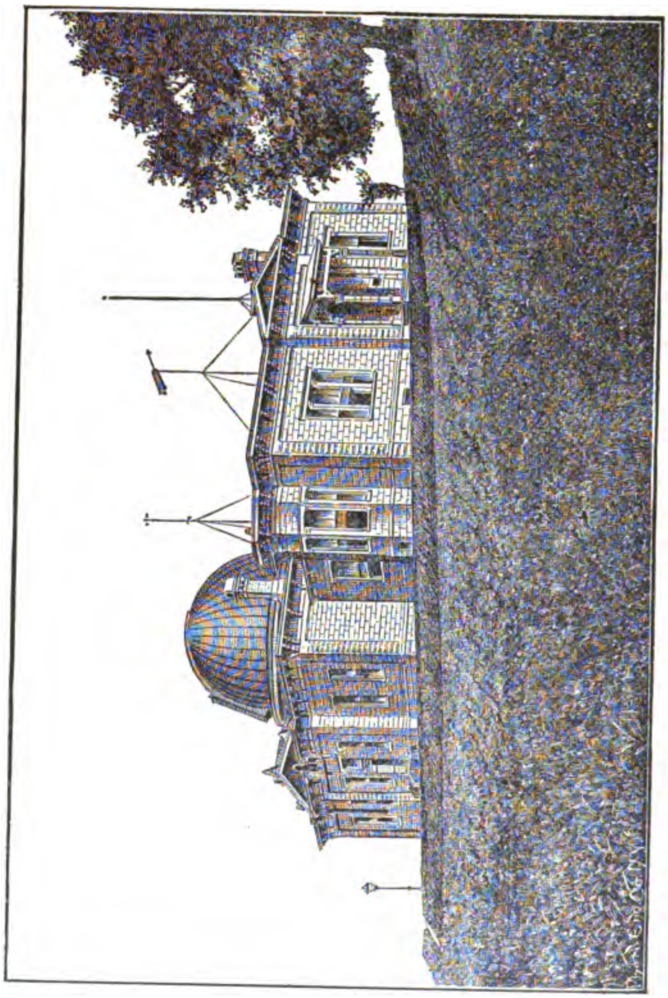
OF THE

WASHBURN OBSERVATORY.

VOL. VI.

PARTS 1 AND 2.

MADISON, WIS.:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS,
1890.



PUBLICATIONS

OF THE

WASHBURN OBSERVATORY.

VOL. VI. PART 1.

OBSERVATIONS WITH THE MERIDIAN CIRCLE,

BY

ALICE MAXWELL LAMB AND MILTON UPDEGRAFF,

ASSISTANTS IN THE OBSERVATORY.

MADISON, WIS.:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS,
1890.

INTRODUCTION.

The manuscript of the following observations was placed in my hands by Miss Lamb in 1887, shortly before she severed her connection with the Washburn Observatory, and for the delay in its publication the authors of the work are in no way responsible. The following explanation of the work accompanied the manuscript.

GEORGE C. COMSTOCK,
Director.

Washburn Observatory, March 1, 1890.

The following observations were made for several purposes. They include: (1.) Observations of the list of stars used in 1884 by Professors Holden and Comstock in determining the latitude of this observatory by means of Zenith Telescope observations. (See Vol. III., *Publications of the Washburn Observatory.*) (2.) Observations of five stars observed at the request of Dr. L. de Ball, used by him as comparison stars for the planet (181), *Eucharis.* (3.) Observations of stars of the Refraction List. (4.) Observations of zero stars from the *B. J.* The observations and reductions were made by Mr. Updegraff and Miss Lamb, according to the methods described in Vol. IV. of the *Publications of the Washburn Observatory.* The microscopes were read by Mr. Updegraff, the pointings at the telescope being made by Miss Lamb. The room was well ventilated before the beginning of each night's work, with the exception of July 11.

The number of observation is

in R. A.	118
in Dec.	266
Total	384

The probable errors in R. A. and Dec. have been determined, using every star that had been observed four or more times in the co-ordinate for which the probable error was sought.

The results are

P. E. of 1 observation in R. A. (Polars included)	$= \pm\ 0^s.044$	(104)
P. E. of 1 observation in R. A. (Polars not included)	$= \pm\ 0^s.037$	(86)
P. E. of 1 observation in Dec.	$= \pm\ 0''.330$	(195)

N. B. These probable errors were computed before the observations of Aug. 29 and 30 had been made, but it is evident that the error would have remained essentially the same if these nights had been included in the computation.

A. M. L.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	
		48 H. Cephei. S. P.		
		3 6 0.490	**+ 77 19 4.94**	
June 15	L.	3 6 0.95	+ 77 19 3.8	W.
16	L.	0.57	3.3	W.
17	L.	0.68	...	W.
23	L.	0.61	...	E.
24	L.	0.61	...	E.
25	L.	0.83	...	E.
		2 H. Camel. S. P.		
		3 19 55.388	**+ 59 32 43.98**	
June 17	L.	3 19 55.31	+ 59 32 44.3	W.
24	L.	.....	44.2	E.
25	L.	.....	45.3	E.
		9 H. Camel. S. P.		
		3 47 30.372	**+ 60 46 36.37**	
June 17	L.	3 47	+60 46 35.8	W.
24	L.	....	35.8	E.
25	L.	....	37.7	E.
		10 Camel. S. P.		
		4 53 22.135	**+ 60 16 32.14**	
Aug. 4	L.	4 53	+ 60 16 33.3	W.
6	L.	....	33.1	W.

Date.	Observer.	R. A., 1887.0			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	
				17 Camel. S. P.				
		5	19	29.921	+ 62	58	16.30	
Aug. 4	L.	5	19	....	+ 62	58	16.9	W.
6	L.			....			17.5	W.
18	L.			....			17.4	E.
23	L.			....			17.6	E.
29	L.			....			17.4	E.
				8 Lyncis. S. P.				
		6	27	21.672	+ 61	34	44.58	
Aug. 6	L.	6	27	....	+ 61	34	45.0	W.
18	L.			....			44.1	E.
23	L.			....			44.0	E.
29	L.			....			44.4	E.
30	L.			....			44.5	W.
				15 Lyncis. S. P.				
		6	47		+ 58	34	10.21	
Aug. 6	L.	6	47	....	+ 58	34	10.5	W.
18	L.			....			9.9	E.
23	L.			....			9.8	E.
29	L.			....			10.8	E.
30	L.			....			9.6	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

83 Bootis.

[+44 53 32.56]

June 16	L.	14 34	+ 44 53 33.6	W.
17	L.	....	32.5	W.
24	L.	....	33.1	E.
25	L.	....	33.0	E.

μ Virginis.

14 37 6.297. — 5 9 59.24

June 15	L.	14 37 6.21	— 5 9 58.5	W.
16	L.	6.22	59.4	W.
24	L.	6.32	59.2	E.
25	L.	....	59.0	E.

109 Virginis.

14 40 32.140 +2 22 10.29

June 15	L.	14 40 32.19	+ 2 22 10.5	W.
16	L.	32.15	10.0	W.
17	L.	32.13	10.1	W.
24	L.	32.19	10.6	E.
25	L.	32.25	9.4	E.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	
		α Librae.		
		14 44 37.636	−15 34 18.55	
June 15	L.	14 44 37.62	−15 34 19.0	W.
16	L.	37.63	18.1	W.
17	L.	37.58	18.4	W.
24	L.	37.65	19.0	E.
25	L.	37.66	18.4	E.
		P. XIV. 221		
		14 50 53.248	+14 54 12.80	
June 15	L.	14 50 53.20	+14 54 12.3	W.
16	L.	53.29	12.5	W.
17	L.	53.23	11.8	W.
24	L.	53.23	12.3	E.
25	L.	53.18	12.5	E.
		β Bootis.		
		14 57 41.378	+40 50 11.94	
June 15	L.	14 57 41.43	+40 50 12.2	W.
16	L.	41.44	12.2	W.
17	L.	41.40	12.2	W.
23	L.	41.38	12.2	E.
24	L.	41.30	11.5	E.
25	L.	41.30	12.2	E.

Date.	Observer.	R. A., 1887.0			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	

κ Bootis.

June 15	L.	15	1	....	+ 48	35	16.8	W.
16	L.			....			16.2	W.
17	L.			....			16.1	W.
23	L.			....			17.6	E.
24	L.			....			16.7	E.
25	L.			....			16.6	E.

δ Bootis.

15 10 56.846 + 33 44 12.74.

June 15	L.	15	10	56.87	+ 33	44	11.4	W.
16	L.			56.80			12.6	W.
17	L.			56.90			12.3	W.
23	L.			56.85			12.7	E.
24	L.			56.84			12.4	E.
25	L.			56.82			12.8	E.

De Ball. 1.

June 15	L.	15	13	28.82	+ 7	24	2.4	W.
16	L.			28.87			3.5	W.
17	L.			28.82			3.4	W.
23	L.			28.93			3.4	E.
24	L.			28.91			3.6	E.
25	L.			28.84			3.8	E.

Date.	Observer.	R. A., 1887.0.			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	

B. A. C. 5071.

June 15	L.	15	17	....	+ 52	21	57.1	W.
17	L.			....			56.7	W.
23	L.			....			57.5	E.
24	L.			....			57.2	E.
25	L.			....			57.3	E.

DE BALL. 2.

June 17	L.	15	23	[13.23]	+ 7	42	52.6	W.
23	L.			[14.06]			52.9	E.
24	L.			13.45			53.0	E.
July 7	L.			13.46			....	W.

June 17, R. A. Observation very poor. Observed only on 2 wires.

June 23. Note: "Poor in R. A. Very faint."

α CORONAE BOREALIS.

		15	29	**54.219**	+27	5	**43.62**	
June 15	L.	15	25	54.23	+27	5	43.8	W.
16	L.			54.16			43.6	W.
17	L.			54.22			43.5	W.
23	L.			54.18			44.1	E.
24	L.			54.23			44.1	E.
25	L.			54.11			43.1	E.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

ψ Lupi.

June 15	L.	15 33	− 34 2 33.7	W.
16	L.	....	33.6	W.
17	L.	....	31.4	W.
23	L.	....	32.2	E.
24	L.	....	30.5	E.
25	L.	....	30.3	E.

γ Coronæ Borealis.

[15 37 59.854] [+ 26 39 14.38]

June 15	L.	15 37	+ 26 39 14.7	W.
16	L.	...	14.8	W.
17	L.	....	15.1	W.
23	L.	....	14.2	E.
24	L.	....	14.6	E.
25	L.	....	15.0	E.

χ Lupi.

July 7	L.	15 44	− 33 16 55.9	W.

ε Serpentis.

15 45 10.964 + 4 49 6.23

July 7	L.	15 45 10.92	+ 4 49 6.2	W.

Date.	Observer.	R. A., 1887.0			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	
				ε Coronae Borealis.				
		15	52	54.548	+ 27	12	20.00	
June 15	L.	15	52	54.66	+ 27	12	19.4	W.
16	L.			54.56			19.8	W.
17	L.			.....			20.0	W.
23	L.			54.52			19.1	E.
24	L.			54.55			19.9	E.
25	L.			54.50			20.0	E.
July 7	L.			54.50			19.4	W.
11	L.			54.58			20.4	W.
				υ Herculis.				
July 7	L.	15	59	....	+ 46	21	2.2	W.
11	L.			....			2.4	W.
				ϑ Draconis.				
		15	59	46.449	+ 58	52	2.20	
June 15	L.	15	59	46.32	+ 58	52	2.6	W.
16	L.			46.35			2.0	W.
17	L.			.....			3.3	W.
23	L.			.....			2.4	E.
24	L.			.....			2.0	E.
25	L.			.....			2.0	E.

Date.	Observer.	R. A., 1887.0			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	
				δ Ophiuchi.				
		16	8	25.417	−3	24	9.67	
June 15	L.	16	8	25.45	−3	24	10.5	W.
16	L.			25.40			10.2	W.
23	L.			25.39			10.3	E.
24	L.			25.52			10.6	E.
25	L.			.....			10.7	E.
July 7	L.			25.40			9.3	W.
11	L.			25.46			10.3	W.
				ε Ophiuchi.				
		16	12	20.529	−4	24	59.37	
June 15	L.	16	12	20.54	−4	24	59.0	W.
16	L.			20.54			59.3	W.
23	L.			20.55			59.2	E.
24	L.			20.58			59.2	E.
25	L.			20.52			58.6	E.
July 7	L.			20.48			58.7	W.
11	L.			20.52			58.8	W.
				19 Ursae Minoris.				
		16	14	3.198	+76	9	41.89	
June 15	L.	16	14	3.26	+76	9	...	W.
16	L.			3.24			....	W.
23	L.			3.28			....	E.
24	L.			3.14			....	E.
25	L.			3.34			....	E.
July 7	L.			3.09			....	W.
11	L.			3.11			....	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	
		***τ* Herculis.**		
		16 16 20.583	**+ 46 34 58.10**	
June 15	L.	16 16 20.65	+ 46 34 58.0	W.
16	L.	.....	58.6	W.
23	L.	20.60	59.0	E.
24	L.	20.64	58.1	E.
25	L.	20.71	58.1	E.
July 7	L.	20.74	57.7	W.
11	L.	20.62	57.8	W.
		Gr. 2343.		
		[16 21 57.118]	**[+ 55 27 44.10]**	
June 16	L.	16 21	+ 55 27 45.1	W.
23	L.	....	44.6	E.
24	L.	....	44.1	E.
25	L.	....	44.4	E.
July 7	L.	....	44.6	W.
11	L.	....	44.6	W.
		32 Herculis.		
June 16	L.	16 29	+ 30 44 11.4	W.
23	L.	....	11.4	E.
24	L.	....	10.8	E.
25	L.	....	10.7	E.
July 7	L.	....	11.5	W.
11	L.	....	11.5	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

B. A. C. 5568.

June 16	L.	16 33	+ 46 50 32.8	W.
23	L.	....	32.2	E.
24	L.	....	32.8	E.
25	L.	....	32.4	E.
July 7	L.	....	32.6	W.
11	L.	....	32.2	W.

η Herculis.

16 39 1.353 + 39 8 15.54

June 16	L.	16 39 1.38	+ 39 8 15.0	W.
23	L.	1.38	14.7	E.
24	L.	1.37	15.3	E.
25	L.	1.40	15.3	E.
July 7	L.	1.31	15.4	W.
11	L.	1.28	14.9	W.

ε Scorpii.

June 16	L.	16 43	− 34 5 12.7	W.
23	L.	....	13.6	E.
24	L.	....	12.4	E.
25	L.	....	14.2	E.
July 7	L.	....	13.4	W.
11	L.	....	14.1	W.
Aug 4	L.	....	13.6	W.
6	L.	....	13.3	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

49 HERCULIS.

16 46 56.186 +15 9 51.99

June 16	L.	16 46 56.24	+15 9 51.5	W.
23	L.	56.22	52.1	E.
24	L.	56.20	52.6	E.
25	L.	56.21	52.0	E.
July 7	L.	56.13	51.8	W.
11	L.	56.14	51.5	W.

DE BALL. 3.

June 16	L.	16 51 6.71	−1 3 50.0	W.
23	L.	6.66	....	E.
24	L.	6.52	47.9	E.
July 7	L.	6.63	50.0	W.
11	L.	6.66	....	W.

DE BALL 4.

July 11	L.	16 52 12.20	−0 58 ...	W.

ANONYMOUS. (*Not in D. M.*)

June 24	L.	16 52 19.01	−1 7 50.4	E.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

ε Ursae Minoris.

16 57 34.448 +82 13 18.58

June 16	L.	16 57 34.56	82 13	W.
24	L.	34.65	....	E.
25	L.	34.67	....	E.
July 7	L.	34.56	....	W.
11	L.	34.55	19.7	W.

De Ball. 5.

June 16.	L.	17 3	+0 10 53.6	W.
23	L.	0.69	54.4	E.
24	L.	0.69	55.2	E.
25	L.	[0.64]	53.0	E.
July 7	L.	0.72	52.0	W.
11	L.	0.70	54.7	W.

June 25. Only 3 wires in R. A. Poor observation.

69 Herculis.

July 7	L.	17 14	+37 25 35.5	W.
11	L.	....	37.0	W.
Aug. 4	L.	....	35.9	W.
6	L.	....	35.9	W.
18	L.	....	37.7	E.
23	L.	....	37.3	E.
29	L.	....	36.5	E.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	
		x Herculis.		
		17 23 44.478	**+48 21 18.26**	
Aug. 4	L.	17 23	+48 21 18.2	W.
6	L.	....	18.4	W.
18	L.	....	18.4	E.
23	L.	....	18.9	E.
29	L.	....	18.3	E.
30	L.	....	18.1	W.
		β Draconis.		
		17 27 52.797	**+52 23 7.08**	
Aug. 4	L.	17 27	+52 23 6.7	W.
6	L.	....	6.2	W.
18	L.	....	7.3	E.
23	L.	....	7.4	E.
29	L.	....	6.8	E.
30	L.	....	6.8	W.
		ι Herculis.		
		17 36	**+46 4 0.38**	
Aug. 4	L.	17 36	+46 4 0.7	W.
6	L.	....	0.8	W.
18	L.	....	0.1	E.
23	L.	....	0.0	E.
29	L.	....	0.1	E.
30	L.	....	0.2	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	
		ξ Draconis. 17 51 35	+ 56 58 26.00	
Aug. 4	L.	17 51	+ 56 53 26.2	W.
6	L.	....	25.9	W.
18	L.	....	25.4	E.
23	L.	....	25.8	E.
29	L.	....	26.1	E.
30	L.	....	26.2	W.
		ξ Herculis. [17 58	+ 29 15 37.45]	
Aug. 4	L.	17 53	+ 29 15 37.7	W.
6	L.	....	37.2	W.
18	L.	....	37.7	E.
23	L.	....	37.4	E.
		γ Draconis. 17 53 58	+ 51 30 8.59	
Aug. 29	L.	17 53	+ 51 30 9.0	E.
30	L.	...	8.8	W.
		36 Draconis. 18 13	+ 64 21 32.23	
Aug. 4	L.	18 13	+ 64 21 32.6	W.
6	L.	....	32.4	W.
18	L.	..	31.8	E.
23	L.	....	32.4	E.
29	L.	....	32.3	E.
30	L.	....	32.4	W.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
1887.		h. m. s.	° ′ ″	

ε Sagittarii.

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
Aug. 4	L.	18 16	−34 26 14.5	W.
18	L.	....	13.0	E.
23	L.	....	13.3	E.
29	L.	....	13.5	E.
30	L.	....	13.0	W.

109 Herculis.

18 18 +21 43 7.86

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
Aug. 4	L.	18 18	+21 43 7.7	W.
6	L.	....	7.8	W.
18	L.	....	8.0	E.
23	L.	....	8.0	E.
29	L.	....	7.6	E.
30	L.	....	7.6	W.

Gr. 2640.

18 35 [+65 23 14.64]

Date.	Observer.	R. A., 1887.0	Dec., 1887.0	Circle.
Aug. 6	L.	18 35	+65 23 14.5	W.
18	L.	....	14.7	E.
23	L.	....	14.5	E.
29	L.	....	14.8	E.
30	L.	....	15.3	W.

Date.	Observer.	R. A., 1887.0			Dec., 1887.0			Circle.
1887.		h.	m.	s.	°	′	″	
				110 Herculis.				
		18	40		+20	26	19.08	
Aug. 4	L.	18	40	....	+20	26	19.4	W.
6	L.			....			19.4	W.
18	L.			....			19.0	E.
28	L.			....			19.1	E.
29	L.			....			19.2	E.
30	L.			....			19.3	W.
				ε Aquilae.				
		18	54		[+14	14	55.37]	
Aug. 4	L.	18	54	....	+14	54	55.4	W.
6	L.			....			55.4	W.
18	L.			....			54.9	E.
28	L.			...			55.4	E.
29	L.			....			55.2	E.
30	L.			....			54.7	W.
				υ Draconis.				
		18	55		[+71	8	45.34]	
Aug. 4	L.	18	55	....	+71	8	45.2	W.
6	L.			....			45.0	W.
18	L.			....			46.0	E.
28	L.			....			45.2	E.
29	L.			....			45.7	E.
30	L.			....			45.1	W.

PUBLICATIONS

OF THE

WASHBURN OBSERVATORY.

VOL. VI. PART 2.

OBSERVATIONS OF DOUBLE STARS,

BY

GEORGE C. COMSTOCK.

MADISON, WIS.:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS,
1890.

The Washburn Observatory.

FOUNDED BY

Cadwallader C. Washburn,

Born 1818; Died 1882.

INTRODUCTION.

During the years 1881–82–83, a considerable part of the working force of the Washburn Observatory was devoted to the search for new double stars, and Vols. 1 and 2 of the Publications of the Washburn Observatory contain the approximate positions of 259 such stars discovered during that period. The relative positions of rather more than one-half of these stars were measured in 1881, by Mr. S. W. Burnham, with the large equatorial of this observatory, but the only determination of the position angles and distances of the remaining stars were the estimates made at the time of discovery.

On assuming charge of the Observatory in August, 1887, I planned as my principal work a determination of the constant of aberration by the method proposed in the *Comtes Rendus* by M. Loewy; but since a considerable time must elapse before the necessary apparatus could be prepared for this work I undertook as a subsidiary programme the measurement of all the double stars discovered at this Observatory, whose positions are given in Vols. 1 and 2 of its Publications. My experience as an observer had been mainly acquired in the use of meridian instruments, and I purposed by this double stár work to familiarize myself with the equatorial, as well as to determine the relative positions of the stars, and by comparison with Burnham's measures, to select from them such as might seem worthy of further investigation on account of large relative motion or other peculiarities.

My inexperience in observations of this kind naturally resulted in the adoption of erroneous methods at the beginning of the work, which could be corrected only after experience had shown their disadvantages. In particular it was my habit to observe under atmospheric conditions (bad seeing) in which I should now refuse to observe; and the rather large discrepancies between observations of the same star on different nights, which are to be found in the course of the work, are in great part due to this cause.

INSTRUMENT:—The instrument employed for all of the measures was the 15½ inch Clark equatorial telescope described in Vol. 1 of the Publications of this Observatory. No essential change has been made in the telescope or micrometer since the date of that description. The instrument appears to be mounted in a very stable manner. The axis was adjusted in October, 1879, and the

instrumental constants ξ and η (Struve) made very small. It remained without further adjustment until August 30, 1887, when the accumulated errors of eight years were removed. It has remained in very close adjustment from that date to the present time. The following are all of the determinations of the positions of the axis of which a record can now be found:

Date.			ξ	η	
1886	Aug.	24–30	−1′.0	−0′.7	
1887	Aug.	23–24	−1 .0	−1 .2	Adjusted.
1887	Aug.	30	−0 .0	−0 .1	
1888	Aug.	3	−0 .1	−0 .3	
1889	March	22	−0 .1	−0 .3	
1890	Jan.	20	−0 .1	−0 .2	

These observations indicate a slight settling of the pier toward the east and north.

The micrometer used in all the observations was the Clark micrometer, with Burnham's end illumination, described in Publications Vol. 1. The eyepieces available for micrometric work were the following:

Designation.	Field.	Power.	Construction.	Maker.
I.	11.6	196.	Ramsden.	Clark.
II.	8.6	284.	Ramsden.	Clark.
III.	5.6	439.	Ramsden.	Clark.
IV.	3.6	792.	Ramsden.	Clark.,
V.	7.7	325.	Steinheil.	Kahler.
VI.	5.1	537.	Steinheil.	Kahler.
VII.	3.4	716.	Steinheil.	Kahler.
VIII.	2.9	850.	Steinheil.	Kahler.
IX.	0.8	1540.	Steinheil.	Kahler.
X.	2.4	660.	Schröder.	Spencer.

Eye-piece IX has been used only for measuring the thickness of the threads, and VII, VIII, and X for only a few observations. Eye-pieces I, II, III, and IV are those employed by Mr. Burnham in 1881, and as the powers here given, differ from those given in Publications, Vol. 1, it seems proper to state that they are the results of a re-determination of the powers. The method which I have employed for this purpose is so simple and accurate that I think it must have been used by others, although I have never seen a reference to it. It consists in measuring with a theodolite (Gauss's method) the value of a revolution of the micrometer screw, *referred to the eye-piece.* The ratio of this value to the value referred to the objective, which is commonly called *the* value of a revolution, is the magnifying power. After the theodolite has been brought into position, it is the work of but little more than a minute to determine the power, with the probable error less than 1-200th part of the quantity itself.

The periodic errors of the micrometer screw were investigated in 1881, by Professor Holden, using for this purpose the measuring engine of the Transit of Venus Commission at the U. S. Naval Observatory, Washington. The result of this investigation, given in Publications, Vol. 2, p. 288, is that * * * "the maximum value of the correction does not amount to 0.″02. We may safely say that the periodic inequalities of this screw from 63 rev. to 73 rev., are far less than the accidental errors of the measures which can be made with it, and need not be further considered."

My observations having been made at a different part of the screw, 47 rev. to 53 rev., from that investigated by Professor Holden, I have thought it advisable to repeat the investigation of these errors. The method adopted is the following: The micrometer, detached from the telescope, was placed in a window in such a manner as to receive good daylight illumination of the threads. By means of a high power eyepiece the micrometer threads were made visible in the telescope of a small theodolite, and with this theodolite the angle moved over by the threads as the screw head was turned from any one tenth of a revolution to the next tenth, was measured. The micrometer eyepiece was reset after each measurement of a tenth of a revolution so that it always occupied the same position relative to the micrometer thread. The accuracy attainable by this method may be inferred from the following table which shows the excess of a measured tenth of a revolution over the mean of all the measured tenths for a given revolution, expressed in units of the fourth decimal place of a revolution of the screw, 0.0001 rev.

TABLE.

Date.	Obs'r.	Eye-piece.	Rev.	r 0.0 0.1	r 0.1 0.2	r 0.2 0.3	r 0.3 0.4	r 0.4 0.5	r 0.5 0.6	r 0.6 0.7	r 0.7 0.8	r 0.8 0.9	r 0.9 0.0
1890.													
Jan. 21	C.	VII.	51.	+ 1	+ 5	— 1	+ 1	— 8	+ 7	— 6	— 3	+ 3	— 2
21	C.	VII.	52.	— 11	— 3	+ 1	+ 5	— 5	— 5	+ 8	+ 4	+ 11	— 4
21	B.	VII.	49.	+ 1	— 3	+ 1	+ 3	+ 7	+ 1	— 10	— 2	+ 3	— 2
21	C.	VII.	50.	— 10	— 2	+ 4	— 6	— 1	— 14	+ 2	0	+ 14	+ 14
22	F.	VII.	48.	— 5	— 5	+ 3	+ 8	— 5	— 1	+ 3	+ 3	— 1	— 1
22	F.	VIII.	47.	— 6	+ 2	— 2	— 6	— 21	+ 17	+ 5	+ 5	+ 2	+ 5
23	C.	V.	47.	— 6	— 9	— 9	+ 13	— 2	+ 1	+ 1	+ 1	+ 10	+ 1
23	F.	VII.	52.	+ 8	— 12	+ 4	+ 1	— 8	+ 4	+ 8	— 8	— 6	+ 10
Means.	....	....	......	— 3	— 3	0	+ 2	— 5	+ 1	+ 1	0	+ 4	+ 3

The following system of corrections to the readings of the micrometer is derived from the mean values of the excesses of the individual tenths of a revolution:

CORRECTIONS FOR PERIODIC INEQUALITY.

r	r	r	r
0.0	0.0000	0.5	—0.0009
0.1	- .0003	0.6	— .0008
0.2	— .0006	0.7	— .0007
0.3	— .0006	0.8	— .0007
0.4	— .0004	0.9	— .0003
0.5	— .0009	0.0	.0000

I think that these corrections represent real errors in the screw, but the maximum correction being less than 0″.01 I have uniformly neglected them, and assumed that the screw is practically free from periodic errors. Upon this

supposition the quantities in the first table are errors of observation and from them I find as the probable error of a number in that table:

$$r = \pm\, 0.00045 \text{ rev.} = \pm\, 0.''005$$

and

$$r_0 = \pm\, 0.00016 \qquad = \pm\, 0.\ 002$$

where r_0 denotes the probable error of the mean of eight determinations. Adopting the mean values given in the table as the values of real errors in the screw would reduce these probable errors to $\pm$ 0.00041 rev. and $\pm$ 0.00014 rev. respectively.

VALUE OF ONE REVOLUTION OF THE MICROMETER SCREW: — The value 10″.48 for one revolution of the screw was determined in 1881 from 131 transits of stars. The individual results being quite discordant and being all made at comparatively high temperatures I have thought it expedient to redetermine the value and to investigate the effect of temperature upon the screw. The first step in this investigation was the determination of the progressive errors of the screw. Through the courtesy of the Superintendent of the U. S. Naval Observatory I was enabled to make this investigation upon the measuring engine of the Transit of Venus Commission. The length of five revolutions, at different parts of the screw, was measured in terms of Scale A. of that engine on two different days at a temperature of approximately 45° F. In the reduction of these observations the division errors of that scale have been taken from the "Second System of Corrections to Scale A."

If the length of a revolution is the same at all parts of the screw the distance moved over by the thread when the screw is turned from any given reading R_0 to any other position R is given by the expression

$$S = (R - R_0)\, k$$

where k is the value of one revolution. If the pitch of the screw is irregular we shall have

$$S = [(R + \sigma) - (R_0 + \sigma_0)]\, k$$

or more simply, adopting R_0 as the origin from which revolutions are measured, and representing by k the value of a revolution at R_0,

$$S = (R + \sigma - R_0)\, k.$$

To each reading of the screw there is a correction σ, by the application of which the effect of irregularities in the pitch is completely eliminated. The following table shows the values of σ obtained from the observations with the measuring engine, and also the adopted values obtained by a process of graphical adjustment. On Dec. 28 the micrometer screw was turned in the direction of increasing readings, on Dec. 29 in the opposite direction.

CORRECTIONS FOR PROGRESSIVE INEQUALITY.

Revolution.	Observed σ, 1887. Dec. 28.	Observed σ, 1887. Dec. 29.	Adopted Values.	
	r	r	r	
5	+0.067	+0.080	+0.072	
				6
10	.067	.070	.066	
				10
15	.056	.057	.056	
				12
20	.035	.043	.044	
				14
25	.030	.030	.030	
				14
30	.019	.013	.016	
				8
35	.008	.008	.008	
				5
40	+ .002	.008	+ .003	
				4
45	— .005	+ .002	— .001	
				1
50	.000	— .000	.000	
				2
55	.002	.002	.002	
				2
60	.003	.010	.004	
				3
65	.003	.008	.007	
				4
70	.010	.011	.011	
				5
75	— .006	.020	.016	
				5
80	....	.023	.021	
				3
85	....	.024	.024	
				0
90	....	.024	.024	
				3
95	....	— .021	— .021	

These corrections to the readings of the screw are confirmed by a series of transits of Polaris observed at intervals of one revolution over the whole length of the screw by one of my students, Mr. S. D. Townley, and also by the transits observed by myself, whose results are given at p. 38. From these last transits I obtain the following comparison of the value of a revolution determined at different parts of the screw:

Date.	Rev.	Value of 1 Revolution.	
		Uncorrected for σ.	Corrected for σ.
1889.		″	″
Oct. 4	4.5 — 51.5	10.427	10.444
Oct. 4	98.5 — 51.5	.446	.452
Nov. 2	5.0 — 51.5	.423	.439
Nov. 2	98.0 — 51.5	.436	.441

The numbers given under the heading Rev., represent the part of the screw used in determining the values placed opposite them.

Assuming the value of one division of Scale A. of the measuring engine to be 0.01989 inches, I find for the pitch of the screw from the observations of

Dec. 28. k = 0.012509 inches = 317.72 microns.

Dec. 29. .012505 inches = 317.63 microns.

These values differ very appreciably from the value 0.012369 inches, obtained by the same method in 1881, and given in *Publications Vol. 2, p. 289.* The explanation of this discordance is to be found in errors of reduction of that work, the engine micrometer corrections having been applied with the wrong sign to the scale readings. Correcting these errors produces a much better agreement among the individual results and gives as the mean value of k from that work, 0.012503 inches. I adopt as the length of one revolution, $k = 0.012505$ inches = 317.63 microns, at the temperature 45° F.

The high degree of precision attainable by means of the measuring engine may be inferred from the agreement among the preceding results, but it appears more plainly from the following table of the average length of one revolution of the screw over a space of ten revolutions. The lengths are expressed in microns.

Revolutions.		Dec. 28.	Dec. 29.	Mean.
5 to	15	317.3	316.8	317.0
10	20	6.6	6.6	6.6
15	25	6.8	6.7	6.8
20	30	7.1	7 1	7.1
25	35	6.8	6.8	6.8
30	40	7.0	7.4	7.2
35	45	7.4	7.3	7.4
40	50	7.6	7.3	7.4
45	55	7.8	7.5	7.6
50	60	7.7	7.8	7.8
55	65	7.7	7.7	7.7
60	70	7.8	7.6	7.7
65	75	7.7	7.9	7.8
70	80	...	7.9	7.9
75	85	...	7.7	7.7
80	90	...	7.6	7.6
85	95	...	7.4	7.4

The variation in the length of a revolution appears unmistakably from these figures.

The method adopted for the determination of the angular value of a revolution of the screw has been the measurement of differences of declinations passing from one well determined star to another, by means of intermediate stars. The following table gives a summary of the stars employed for this purpose:

Fundamental Stars.	$\Delta\ \delta$	No. of steps.	No. of nights observed.
24–28 *Pleiadum.*	41′.6	6	8
43 *H. Cephei–Br.* 95.	53.6	11	6
$\varepsilon - \zeta$ *Aquilae.*	73.2	12	2
$\nu^2 - \varphi$ *Bootis.*	33.7	6	1

For the purpose of comparison between different methods, the value of the screw was also determined upon two nights from transits of a cluster of small stars, 9 to 11 m, in R. A., $23^h\ 53^m.3$, Dec. $+63°0'$. The differences of right ascension of the stars employed, seven in all, are sufficient to enable the successive transits over the same thread to be observed well and are also small enough to permit all of the transits over the first thread to be observed before the first star reaches the second thread, the fixed and movable micrometer threads being set for this purpose 47 revolutions apart.

The observations of differences of declination were made by two essentially different methods. For all the pairs except the second, the telescope was at rest and the stars were bisected with the micrometer thread at the instant of their transit over a fixed thread placed parallel to a declination circle. This method of observing is so well known that no explanations seem required beyond the statement that the values of $\Delta\delta$ required in the reduction were obtained for the *Pleiades* stars from Elkin's heliometer measures (*Yale Transactions, Vol. 1, p. 87*), and for the *Aquila* and *Bootes* stars from the *Berliner Jahrbuch.*

The second pair of stars is on the border of the Galaxy near the pole, and was selected with special reference to a determination of the temperature coefficient of the screw; its peculiar advantage for this purpose being that it can be observed at all seasons of the year in essentially the same position of the observer, thereby eliminating errors in the adopted star places and (in part) subjective errors arising from a changed position of the observer. The arc seems so well adapted to this purpose that I give in some detail the method of treatment of the observations.

The approximate positions of the stars for the epoch 1890.0, are:

43 *H. Cephei*	$0^h\ 53^m\ 48^s$,	$+85°\ 40'.0$
Br. 95	0 57 38,	+ 86 33 .6

The particular set of intermediate stars which I have found most convenient are the following: The relative positions of the stars are expressed in a system of spherical co-ordinates whose positive axis of x is directed toward the pole, and positive axis of y in the direction of increasing right ascensions.

Star.	Mag.	Δx.	Δy.	Δ R.A.
		′	′	m.
43 *H. Cephei.*	4.3			
		+2.8	+6.5	+5.7
a	9.5			
		6.0	+1.4	+1.3
b	9.0			
		2.4	−6.6	−6.0
c	8.8			
		5.5	+2.1	+2.0
d	9.0			
		5.7	+2.8	+2.6
e	10.0			
		7.2	−0.6	−0.6
f	9.0			
		6.4	+4.1	+4.1
g	9.0			
		6.1	+2.6	+2.6
h	9.0			
		1.7	−4.7	−4.9
k	8.5			
		5.5	−3.9	−4.2
l	9.0			
		+4.2	+1.2	+1.3
Br. 95.	6.2			

The differences of right ascension given above are so great that the method of observing adopted for the other stars is here inconvenient, and I have therefore made use of the driving clock to keep the stars in the field, symmetrically placed, and have measured directly the x component of the distance between the stars.

Correction of the Observations for Curvature and Refraction. If the stars are supposed situated upon a sphere of unit radius we have the familiar relations between their rectangular and polar co-ordinates:

$$x = \cos\delta\cos\alpha$$

$$y = \cos\delta\sin\alpha$$

$$z = \sin\delta$$

The rectangular co-ordinates may be transformed into their corresponding values in any other system by revolving the primitive system first about the axis of z through the angle A, and then about the axis of y through the angle D; the particular values assigned to A and D determining the resulting system. The transformation formulæ are:

$$x' = \cos\delta\cos(\alpha - A) \qquad x'' = x'\cos D + z'\sin D$$

$$y' = \cos\delta\sin(\alpha - A) \qquad y'' = y'$$

$$z' = \sin\delta \qquad z'' = -x'\sin D + z'\cos D,$$

In the system of co-ordinates represented by the micrometer threads which measure the Δx and Δy of the stars, the axis of z must be supposed to pass through the middle point of the fixed thread, parallel to the line of sight of the telescope, while the axis of x is directed toward the north pole. Since one of the stars must always be observed on the fixed thread we may put

$$A = \tfrac{1}{2}(\alpha_1 + \alpha_2), \qquad D = 90^\circ + \delta_1$$

where the subscripts 1 and 2 refer to the stars on the fixed and movable threads respectively. Introducing these values of A and D and dropping the accents we obtain in the new system:

$$x_1 = \sin\delta_1 \cos\delta_1 - \sin\delta_1 \cos\delta_1 \cos\tfrac{1}{2}(\alpha_1 - \alpha_2). \quad y_1 = \cos\delta_1 \sin\tfrac{1}{2}(\alpha_1 - \alpha_2)$$

$$x_2 = \sin\delta_2 \cos\delta_1 - \sin\delta_1 \cos\delta_2 \cos\tfrac{1}{2}(\alpha_1 - \alpha_2). \quad y_2 = \cos\delta_2 \sin\tfrac{1}{2}(\alpha_2 - \alpha_1)$$

whence

$$\Delta x = x_2 - x_1 = \sin(\delta_2 - \delta_1) \left\{ 1 - 2\sin\delta_1 \sin\tfrac{1}{2}(\delta_2 + \delta_1) \sin^2\tfrac{1}{2}(\alpha_1 - \alpha_2) \right\}$$

Since in the actual measurements (double distances) each star is observed alternately on the fixed and movable threads we may write in general

$$x_2 - x_1 = \sin(\delta_2 - \delta_1) - 2\sin(\delta_2 - \delta_1)\sin^2\tfrac{1}{2}(\delta_2 + \delta_1)\sin^2\tfrac{1}{2}(\alpha_2 - \alpha_1)$$

and

$$y_2 - y_1 = 2\cos\tfrac{1}{2}(\delta_2 + \delta_1)\cos\tfrac{1}{2}(\delta_2 - \delta_1)\sin\tfrac{1}{2}(\alpha_2 - \alpha_1)$$

or, very approximately,

$$(y_2 - y_1)\tan\tfrac{1}{2}(\delta_2 + \delta_1) = 4\sin\tfrac{1}{2}(\delta_2 + \delta_1)\sin\tfrac{1}{2}(\alpha_2 - \alpha_1).$$

Introducing this expression into the value of $x_2 - x_1$ it becomes

$$x_2 - x_1 = \sin(\delta_2 - \delta_1) - \tfrac{1}{8}\sin(\delta_2 - \delta_1)\left\{ (y_2 - y_1)\tan\tfrac{1}{2}(\delta_2 + \delta_1) \right\}^2$$

whence, in seconds of arc,

$$\delta_2 - \delta_1 = x_2 - x_1 + \tfrac{1}{8}(x_2 - x_1)(\sin\Delta y \tan\delta)^2$$

The last term in this expression is the correction for curvature.

Since in practice the correction for curvature rarely amounts to 0."05, we may neglect it in deriving the effect of refraction and put

$$R(x_2 - x_1) = R\delta_2 - R\delta_1$$

where R denotes the effect of refraction upon the quantity placed after it

Employing Bessel's auxiliary N, we have for the refraction in declination

$$R\,\delta \;=\; k \cot (N + \delta)$$

where

$$k \;=\; \alpha\,\beta^{A}\,\gamma^{\lambda} = 57''$$

approximately.

$$R\,(x_2 - x_1) \;=\; k\,[\,\cot (N_2 + \delta_2) - \cot (N_1 + \delta_1)\,]$$

$$= \; -k.\frac{\sin\,[\,(N_2 - N_1) + (x_2 - x_1)\,]}{\sin^2 (N + \delta)}$$

approximately.

The quantity $N_2 - N_1$ is a function of the hour angles of the stars at the instant of observation and therefore involves $\varDelta\, y$. We may write

$$N_2 - N_1 = \frac{dN}{dt}\varDelta\, t = -\frac{dN}{dt}\varDelta\, \alpha = -\frac{dN}{dt}\sec\delta \cdot \varDelta\, y.$$

The $\frac{dN}{dt}$ is $-\cot\varphi \sin t \cos^2 N$ and the substitution of this expression in the equation above gives a comparatively simple expression for the refraction in x, but it is more convenient in practice to derive the numerical value of $\frac{dN}{dt}$ from the column of differences in a table of N, since this table must be consulted in order to obtain the value of $\sin\,(N + \delta)$.

The corrections for refraction must be computed for the observations of each night, but the correction for curvature, being practically constant may be applied as a correction to the difference of declination of the end stars of the arc. For the stars which I have employed the total correction amounts to 0″.07.

The difference of declination of *43 H. Cephei* and *Br. 95* has been derived from a discussion of the places in all of the catalogues accessible to me, which contain observations of both stars. In every case I have taken from the catalogue not the declinations of the stars but the difference of declination, thus avoiding in great part the effect of systematic errors in the catalogue places. In addition to the data obtained from catalogues I have used a series of eight determinations of the difference of declination of the stars, made at my request by Professor Brown and Mr. Egbert, with the meridian circle of the Washburn Observatory, between August 22, and September 11, 1888.

For the discussion of the data I derive from the Pulkowa *Catalogue of 3542 Stars* the following provisional values of the coordinates for the epoch 1865.0.

43 H. Cephei	R. A. $= 0^h\,50^m\,52^s.1$,	$\mu = +\,0^s.0690$	Dec. $= 85°\,31'\,52''.0$	$\mu' = -\,0''.005$
Br. 95,	$= 0\;\;54\;\;\;8\;.9$	$= +\,0\;.0592$	$= 86\;\;25\;\;27\;.8$	$= -\,0\;.016$

The values of the proper motions here given are the catalogue values adapted to Oppolzer's precession constants. With these values I have derived from Oppolzer's tables (*Lehrbuch der Bahnbestimmung, Vol. 1, 2nd Edition*) the following expressions for the variations of the declinations.

$$43\ H.\ Cephei,\ \delta_T = \delta_{1865} + 19''.5583\ (T-1865) - 11''.60 \left\{\frac{T-1865}{100}\right\}^2 - 1''.49 \left\{\frac{T-1865}{100}\right\}^3$$

$$Br.\ 95.\quad \delta_T = \delta_{1865} + 19\ .4771\ (T-1865) - 14\ .41 \left\{\frac{T-1865}{100}\right\}^2 - 2\ .24 \left\{\frac{T-1865}{100}\right\}^3$$

whence

$$\Delta\delta_T = \Delta\delta_{1865} - 0''.076\ (T-1865) - 2\ .81 \left\{\frac{T-1865}{100}\right\}^2 - 0\ .75 \left\{\frac{T-1865}{100}\right\}^3$$

By means of this expression the catalogue values of $\Delta\delta$ for the several epochs were reduced to 1865.0. The resulting values with the weights assigned them are exhibited in the following table:

Authority.	Date of Observation.	No. of Observations.	$\Delta\delta_{1865}$.	p.	v.
			"		"
Auwers' Bradley, . .	1752.0	59 — 29	3215.69	2.0	+0.71
Fedorenko, Lalande .	1790.0	2 — 2	16.11	0.0	+0.18
Piazzi, ...	1800. ?	5 — 6	18.04	0.5	−1.78
Groombridge, . . .	1807.5	7 — 6	16.70	0.5	−0.46
Schwerd, ...	1827.7	2 — 2	15.13	0.5	+1.05
Henderson, ...	1838.0	10 — 10	16.53	2.5	−0.38
Radcliffe, I. . . .	1848.4	12 — 7	17.13	2.0	−1.01
Paris, (Gambey Circle)	1849.4	6 — 1	14.44	0.5	+1.68
Carrington, . . .	1855.0	3 — 4	16.37	1.0	−0.27
Radcliffe, II. . . .	1857.4	4 — 5	17.00	2.0	−0.91
Brussels, ...	1864.1	3 — 4	16.19	2.0	−0.12
Pulkowa, 3542 Etoiles	1865.6	4 — 4	15.89	7.0	+0.18
Greenwich '64, . .	1866.2	9 — 3	16.24	3.5	−0.17
Greenwich '72, . .	1874.2	3 — 4	15.08	3.0	+0.96
Greenwich '81–'86, .	1884.7	26 — 16	16.36	6.0	−0.35
Madison, ...	1888.7	8 — 8	15.71	8.0	+0.29

The title Greenwich '81–'86 refers to the annual volumes of these and intermediate years.

In the assignment of weights I have been guided by the equation,

$$p = \frac{n_1 \, n_2}{(n_1 + n_2)\, r^2 + 2 n_1 \, n_2 \, g^2}$$

where n_1 and n_2 denote the number of observations of the two stars respectively, r the assumed probable error of a single observation, and g the effect of undetermined constant errors, *e. g,.* division errors, flexure, etc. From a least square solution of this data in which $\Delta\,\delta$ and the coefficient of the first power of the time are treated as unknown quantities I obtain as the definitive expression for the difference of declination of the stars:

$$\Delta\delta_{\mathrm{T}} = \underset{\pm\, 0''.11}{3216''.07} - \underset{\pm\, 0''.34}{7''.91} \left\{ \frac{\mathrm{T} - 1865}{100} \right\} - 2''.81 \left\{ \frac{\mathrm{T} - 1865}{100} \right\}^2 - 0''.75 \left\{ \frac{\mathrm{T} - 1865}{100} \right\}^3$$

The residuals, $v = C.-O.$, corresponding to this expression are given above. The probable error of an equation of weight 1 is $\pm\, 0''.68$.

The reduction of the mean $\Delta\,\delta$ for the beginning of any year to the apparent equinox of a given date is most conveniently made by the Bessel constants, as follows:

$$\textit{Reduction} = -\left\{ 0''.012\, \tau + [8.906]\, \mathrm{A} + [8.210]\, \mathrm{B} + [8.365]\, \mathrm{C} + [7.475]\, \mathrm{D}. \right\}$$

The several determinations of the value, in arc, of one revolution of the micrometer screw are as follows, each result being derived from the observations of a single night.

ε and ζ Aquilae.		*ν² and φ Bootis.*		*Transits, δ = 60°.*	
10''.429,	*Temp.* 74°, *F.*	10''.436,	*Temp.* 43°, *F.*	10''.448,	*Temp.* 54°, *F.*
.428	71			.440	44

24 and 28 Pleiadum.		*43 H. Cephei and Br. 95.*	
10''.440,	*Temp.* + 4, *F.*	10''.450,	*Temp.* + 74, *F.*
..457	− 3	.453	+ 78
.438	− 7	.447	+ 56
.445	− 10	[.416]	+ 30
.455	+ 1	.458	+ 33
.442	+ 61	.456	+ 30
.445	+ 57		
.442	+ 55		

The several results of each series are given in chronological order. The bracketed value in the last series, 10.416, has been rejected, since the observations contain intrinsic evidence that the position circle of the micrometer was set at a wrong reading on that night, every difference of declination corresponding to a positive Δy between the stars observed being too great, and every one corresponding to a negative Δy being too small. The micrometer should have been set at the reading 26°.0. If we assume that it actually was set at 24°.0 and correct the results for this error we shall obtain for the value of one revolution 10″.452, but I have preferred to reject the result rather than make this supposition.

The temperature coefficient of the screw must be derived from the last two series, and from these there results:

24—28 *Pleiadum*,	1 *rev.*	$= 10''.445 - 0''.00007\,(t - 32°)$
43 *H. Cephei—Br.* 95		$= 10\,.451 - 0\,.00014\,(t - 32°)$

where t denotes the temperature in degrees Fahrenheit.

Adopting $-0''.00010$ as the temperature coefficient and assigning equal weights to the several determinations of the value of one revolution I obtain:

$$1 \text{ rev.} = 10''.4457 - 0.00010\,(t.- 32°).$$

There is some indication that the discordances among the results of the several series are of a systematic character, the value of a revolution increasing with the declinations of the stars from which it is derived. Neglecting this apparently progressive character of the results and treating the residuals as due solely to accidental error of observation, I find for the probable error of the result of a single night's work, $r = \pm\, 0''.006$, and for the probable error of the mean result given above, $r = \pm\, 0''.0014$. As the greatest distance which can be measured with this micrometer is less than 50 revolutions, this probable error seems sufficiently small, and I therefore adopt the value given above.

This value combined with the linear pitch of the screw obtained from the measuring engine as above described, gives as the focal length of the objective, 247.0 inches, = 627.4 centimeters. The clear aperture of the objective being 15.56 inches, = 39.52 centimeters, the ratio of focal length to aperture is 15.9.

The effect of temperature upon a measured distance may be put in the form

$$D = D_{\circ}\,(1 - 0.0000172\,T)$$

where T is expressed in degrees Centigrade. This value should be compared with those given in the *Vierteljahrsschrift der Astron. Gesell. Vol. 23, p. 187.*

Methods of Observing.—In all of my double star observations I have employed bright wires in a dark field. The illumination is substantially the same as that described in *Publications, Vol. 1,* save that for the later observa-

tions the oil lamp shown in Vol. 1 was replaced by a small incandescent lamp worked by two cells of a bichromate of soda battery. The latter illumination furnishes no improvement in the appearance of the micrometer threads, but it is much neater and gives off far less heat than the oil lamp.

The threads have been frequently broken during the progress of the observations but have been renewed from the same cocoon. The thickness of the threads has been measured from time to time and as might be expected I find that bright threads in a dark field subtend a greater angle than do dark threads in a bright field. The respective angular diameters in the two cases are 0″.24 and 0″.20. This difference is not due to bad illumination of the bright threads, since they appear as sharp and well defined as the dark threads in a bright field.

It being much more convenient to use the micrometer with the lamp above the eyepiece than with the lamp below, I have, in general, observed position angles in only one position of the micrometer, and have read only one vernier. From an investigation of the position circle made in 1884 by Mr. Tatlock, I find for the correction to reduce a reading of one vernier to the mean of both

$$\textit{Ver. A.} \qquad -0.^\circ 033 \ - \ 0.^\circ 011 \sin (A-1^\circ)$$

$$\textit{Ver. B.} \qquad +0.\ 033 \ - \ 0.\ 011 \sin (B-1\ )$$

These corrections have been neglected.

The parallel has usually been determined by placing the fixed and movable threads in coincidence and allowing a seventh or eighth magnitude star to be carried along them, either by the diurnal motion or by moving the telescope about the polar axis by means of its slow motion. Occasionally it has been determined by setting the threads at a known distance apart, making an angle of about three degrees with the parallel, and observing transits of an equatorial star over them. The correction to the reading of the position circle to reduce to the reading of the parallel is given by the equation,

$$\sin i = [9.842] \frac{d}{t} \sec \delta$$

where d is expressed in revolutions of the screw and t in seconds of time. A comparison of the results obtained by the two methods shows no systematic difference between them. The errors of adjustment of the polar axis have been so small that the zero of the position circle may be assumed the same for all parts of the heavens. The parallel has been determined upon every night on which position angles were measured.

In the measurement of position angles the stars have usually been placed between parallel threads, the micrometer being turned to and fro by the rapid motion pinion until the line joining the stars was estimated to be parallel to the threads. Occasionally the stars have been placed near a single thread and rapidly oscillated from side to side of the thread, while the latter was

turned until parallel to the line of the stars. From three to five settings of the position circle constitute a determination of position angle. In every case the eye was withdrawn from the telescope between settings and the micrometer turned several times in each direction through an arc of 40 or 50 degrees in order that the subsequent settings might not be biased by the previous ones.

The measures of distance have uniformly been made by the method of double distances, two or three settings of the movable thread on each side of the fixed thread constituting a single measure Two different methods of observing distances have been followed for the closer stars. (*a*), The ordinary method of bisecting each star with a micrometer thread; and (*b*), the threads being placed near the stars and perpendicular to the line joining them, the screw was turned until the distance between the threads was estimated equal to the distance between the stars. By repeated experiments I have found that the probable (accidental) error of a single setting made by method *b* is not greater than the corresponding error of method *a*, for stars whose distance is less than a certain limiting amount, which will be represented by *d*; but for stars whose distance is greater than *d*, the relative error of method *b* increases very rapidly. The advantage of *b* lies mainly in the case of bad seeing.

During the autumn of 1887 a considerable portion of my measures of distance were made by method *b*, and no distinction was made between the two methods save that *b* was employed chiefly when the images were diffuse or very unsteady. After 1887, October 31, the method by which each measure of distance was made was recorded in the note book, and the letters *a*, *b*, appended to the measured distances contained in the following pages have reference to the mode of measurement. Systematic differences between the results of measures made by the two methods were to be expected, and I find that distances measured by method *a* are uniformly greater than by *b*. The corrections which must be applied to measures of the latter class to reduce them to the former have been determined from a consideration of all the cases in which the same star was observed on the same night by both methods. There are 65 cases of this kind, and since the interval of time between the two measures does not much exceed ten minutes in any of them, variations of personal equation can have but little influence upon the resulting corrections.

The magnitude of subjective errors of this kind may fairly be assumed to depend upon the appearance presented by the stars to the observer's eye, and therefore to be a function of the magnifying power employed in the observations. In discussing the individual determinations of the corrections under consideration I have employed a graphical process, each observed correction being represented by a point whose abscissa is proportional to the apparent angle under which the stars were presented to the eye, and whose ordinate is the excess of

the distance measured by method a over that measured by b. The abscissas were obtained by the formula

$$x = \frac{ps}{200}$$

where p is the magnifying power, and s the distance measured by method b. These measures indicate that method b ought not to be employed for values of x much exceeding 3″, and certainly not for values greater than 4″. I adopt as the limiting value above defined $d = 700/p$, or since no very great precision is required in the use of this expression, for the eyepieces most commonly employed d has the following values:

I. 3″.5, II. 2″.7, III. 1″.6, IV. 1″.0, V. 2″.2, VI. 1″.2.

Through the plotted points representing the several determinations of the corrections to reduce the measures by method b to the standard, a, I have drawn a curve whose general character is shown in the following table of corrections obtained from it:

CORRECTIONS TO THE b MEASURES.

x.	Corr.	x.	Corr.	x.	Corr.
1″.0	+ 0″.12	2″.0	+ 0″.42	3″.0	+ 0″.53
.2	.19	.2	.46	.2	.53
.4	.26	.4	.49	.4	.54
.6	.33	.6	.51	.6	.54
.8	.38	.8	.52	.8	.55
2.0	.42	3.0	.53	4.0	.56

The corrections actually applied to the b measures in order to obtain the corrected distances given in the following pages have been read directly from the curve from which the above table was constructed.

I have in general rejected measures by method b when x exceeded $700/p$, but in a few cases where x was but little greater than this limit I have retained the observation.

At times when the seeing was bad I have cut down the aperture of the telescope, usually to ten inches but occasionally to six. Observations made with diminished aperture are denoted in the following pages by the remarks, X inch

and VI inch. I have also employed caps to diminish the spherical aberration of the Ramsden eyepieces. These caps placed between the eye of the observer and the eye lens of the ocular considerably diminish the aperture of the latter and furnish much sharper images of the threads. The Steinheil and Schröder eyepieces require no such capping.

I have not in general recorded the character of the seeing or assigned a weight to the observations.

MAGNITUDES. In estimates of magnitude I have conformed as closely as possible to Burnham's scale, which is in substantial agreement with Argelander, but for the fainter stars my estimates are probably too bright. The faintest star which I can see and measure is 13.5 on my scale, while the *minimum visibile* of the telescope is 15.1 Argelander. An approximate determination of the relation between my magnitudes and those of W. Struve for the brighter telescopic stars, may be obtained from a list of eighty-four estimates of the magnitudes of eleven Struve stars between the seventh and ninth magtudes. The average value of the difference Σ. — C. is —0.3 m., in excellent agreement with the known difference, Σ. — Arg. = — 0.3 m. at this part of the scale.

SYSTEMATIC ERRORS OF THE OBSEVATIONS. Since the experience of others seems to show that the personal equation in observations of double stars is subject to considerable changes with the lapse of time, and that these changes are especially great in the case of an observer inexperienced in work of this kind, I have not thought it expedient to make any elaborate determination of the systematic errors affecting my measures of position angle and distance. I have not, however, allowed these errors to remain wholly undetermined. Many of the stars of my observing list having been measured by Mr. Burnham in 1881, an epoch removed only seven years from the mean date of my observations, a comparison of my results with his may be made upon the assumption that the relative motions of the stars in this interval are insensible. In the case of a single star, or a small number of stars, this assumption would seem hardly legitimate, but where a considerable amount of material is available for discussion, the errors which may result from the assumption are very much diminished.

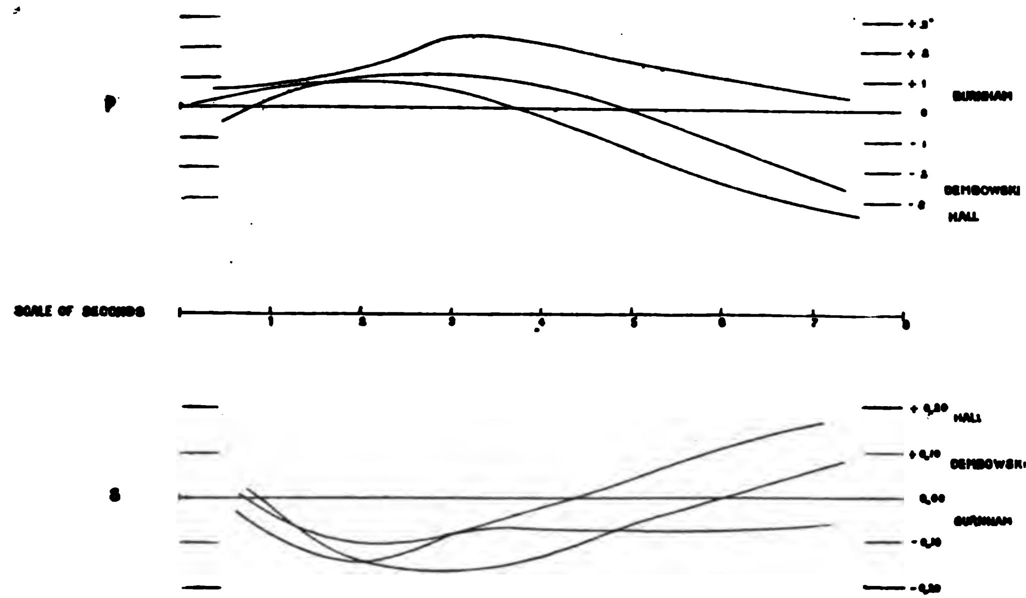
I have made this comparison with Burnham, rejecting from it six stars in which large relative motions seem to be indicated. There are 153 stars available for a determination of the systematic differences *β*.— *C*. Arranging these in the order of distance and uniting them into groups I obtain:

Distance.		β.— C. p.	β.— C. s.	No. of Stars.
0″.0 to	1″ 0	+1°.1	−0″.06	20
1 .0	1 .6	+1 .0	− 12	24
1 .6	2 .3	+0 .3	− .22	31
2 .3	3 .0	+2 .9	− .08	18
3 .0	4 .0	+2 .2	− .06	23
4 .0	6 .0	+1 .9	− .08	15
6 .0	. . .	+0 .3	− .06	22

The permanence of sign and the magnitude of the quantities contained in this table indicate the presence of very considerable systematic differences between Burnham's measures and mine; and these differences should be taken into account before combining our results. The comparison of the individual stars which are united to form the means given above will be found in connection with the observations, upon subsequent pages. In making these comparisons the effect of precession, and the systematic error depending upon the angle made by a vertical circle with the line joining the two stars has been neglected.

Material of a somewhat different character is available for a comparison of my measures with those of Baron Dembowski and Professor Hall. From the list of thirty stars selected by Mr. Otto Struve, to be measured at approximately the same epoch by Dembowsky, Hall, and himself for the determination of their respective errors (*Vierteljahrsschrift der Astron. Gesell.*, *Vol.* 11, *p.* 227), I have selected all of the stars, ten in number, whose distances are included between 0″.7 and 8″.0 and have measured these stars in widely different hour angles as often as occasion would permit. Each measurement has consisted of five settings of the position circle and three double distances (method *a*). With very few exceptions the measures have been made with a magnifying power of 325 diameters, eyepiece V. During the progress of this work I have avoided all knowledge of the results obtained by other observers.

I have examined graphically my position angles and distances of these stars to determine whether they are affected with any systematic errors depending upon the position angle of the stars with respect to the vertical. The material is insufficient for this purpose, but two of the stars whose distances are less than 3″.0 indicate the presence of a term of the form $k \sin (2V + K)$ where V denotes the position angle of the stars with respect to a vertical circle and k is


P
BURNHAM
DEMBOWSKI
HALL
+ 3°
+ 2
+ 1
0
- 1
- 2
- 3
SCALE OF SECONDS
1
2
3
4
5
6
7
8
S
+ 0,20
+ 0,10
0,00
- 0,10
- 0,20

proximately equal to 1°.5. The remaining stars whose distances are greater han 3″.0 give no certain indication of such an error. If an error of this kind is due to astigmatism of the eye, it ought not to occur in my observations, for the astigmatism of my left eye, with which all of the measures were made, is much below the normal amount. I have held my head erect, in as nearly as possible the natural position, in all of the observations.

The mean epoch of my observations of the stars selected for comparison, may be taken as 1889.0, while the epochs of the measures of Dembowski and Hall are 1877 and 1878, respectively. The large interval of time between these epochs and my own would render the measures unsuited for comparison were it not that the stars were selected with special reference to the fact that the relative motions of the components are very small, in most cases insensible. The greatest motion occurs in the case of the star 0.Σ .489, and for this star I have reduced my measures to the epochs of Dembowski and Hall by means of von Glasenapp's elements, *Astr. Nachr. No.* 2940. The other cases in which the corrections for relative motion are appreciable are Σ 2452, Σ 2603, and Σ 2675. For these stars the reductions to the epoch 1887 have been made by comparison with the observations of W. Struve, 1832, employing the principle that the radius vector in the apparent ellipse sweeps over equal areas in equal times. In this comparison corrections for precession were applied to reduce Struve's observations and my own to the mean epoch of Dembowski's and Hall's measures, but the effect of precession upon these measures was neglected since their interval from the mean epoch did not in any case much exceed a year.

The use thus made of the observations of W. Struve has rendered impracticable a determination of our relative errors, and as the more recent observations of Otto Struve are not accessible to me I am compelled to forego comparison with both of these distinguished observers.

For comparison with the observations of Professor Hall, there is available in addition to the observations above described, a set of nearly simultaneous measures of ζ *Herculis* and 70 *Ophiuchi*. Professor Hall's observations of the latter star are published in *Gould's Astronomical Journal, No.* 202, and those of the former star were kindly communicated to me in manuscript.

The following table gives the comparison between my observations, reduced to the epoch 1877, and those of Dembowski and Hall.

COMPARISON WITH DEMBOWSKI AND HALL.

STAR.	R. A.		Dec.		Mags.		DEMB.—C.		HALL—C.		NO. OF OBSERVATIONS.					
							p	*s*	*p*	*s*	*D.*		*H.*		*C.*	
	h	m	°	′			°	″	°	″						
Σ 2924 . .	22	30	+69	21	7	7	−4.7	−0.03	+0.2	−0.03	50	24	13	13	4	4
O Σ 489 . .	23	4	74	47	5	8	+0.4	+ .09	+5.5	+ .13	53	19	14	14	6	6
Σ 2034 . .	16	2	83	57	7	8	+0.5	− .01	+0.4	− .03	19	7	17	17	3	3
Σ 2801 . .	21	22	79	52	7	8	−0.6	− .14	+0.4	− .02	37	17	12	12	9	8
ζ *Herculis*	16	37	31	49	3	6	....	....	+1.8	− .25	....		12	12	7	7
70 *Ophiuchi*	17	59	2	32	4	6	....	....	+0.4	− .08	....		12	12	8	8
O Σ 481 . .	22	42	77	52	7	9	+1.6	− .19	+3.1	− .10	28	13	10	10	12	12
Σ 2603 . .	19	49	69	59	4	8	+1.2	− .10	+1.7	.00	46	24	13	13	11	9
Σ 170 . .	1	45	75	41	7	8	+0.4	− .21	−0.1	− .15	38	17	12	12	11	11
Σ 191 . .	1	53	73	19	6	8	−1.0	+ .01	−2.4	+ .16	26	16	17	17	10	10
Σ 2452 . .	18	57	75	38	7	8	−0.1	− .05	−1.5	+ .05	26	15	10	10	8	8
Σ 2675 . .	20	13	77	23	4	8	−2.5	+ .07	−3.4	+ .16	32	18	10	10	9	9

This comparison and also the comparison with Burnham are shown graphically in the accompanying plate. The general agreement is striking and indicates marked personal peculiarities in my observing, particularly at distances of from 2″ to 3″. Although the curves showing the relation of my measures to those of Dembowski and Hall cannot be considered definitive, I have constructed from them and the Burnham curve the following table of corrections to be applied to my measures in order to render them comparable with those of these observers:

TABLE OF CORRECTIONS.

s.	*Demb.—C.*		*Hall — C.*		*Burnh.—C.*	
	p.	*s.*	*p.*	*s.*	*p.*	*s.*
″	°	″	°	″	°	″
1	+ 0.3	—0.02	+ 0.6	—0.03	+ 0.8	—0.08
2	+ 1.0	— .14	+ 0.9	— .10	+ 1.3	— .14
3	+ 1.1	— .16	+ 0.6	— .08	+ 2.4	— .08
4	+ 0.8	— .13	— 0.2	— .02	+ 2.2	— .07
5	+ 0.0	— .06	— 1.3	+ .04	+ 1.6	— .07
6	— 1.1	.00	— 2.4	+ .11	+ 1.1	— .07
7	— 2.2	+ .06	— 3.2	+ .16	+ 0.6	— .06

I have published in *Gould's Astronomical Journal, No.* 171, an account of some experiments made by placing in front of the objective of the telescope, a cap containing two circular apertures near opposite extremities of a diameter of the cap, and measuring the distance between the images of a star formed by rays passing through these apertures. If the telescope is perfectly focussed these images, of course, coincide, but if it is out of focus, the images are separated by a distance depending upon the distance between the focal planes of the objective and eye-piece. It is shown in the article cited, that the focus of the objective may be determined in this way with great precision. If after the focus has been determined the eyepiece and micrometer threads be displaced through a given linear distance, q, the angular distance between the images of the stars will be given by the equation

$$s = 206265 \frac{Bq}{f(f+q)}$$

where B is the linear distance between the centers of the apertures and f is the focal length of the objective. In accordance with a suggestion made in that article I have endeavored to determine the absolute error of my measures of distance by comparing the measured distances of the images, with the values of s given by the above equation, employing both positive and negative values of q in order to eliminate any error in the determination of the focus. Owing to the diffuse appearance of the images, distances less than 3″ cannot well be measured, and it seems doubtful whether the corrections determined at distances at which the observations can be conveniently made, will be the corrections required for observations of double stars. The latter consideration has deterred me from expending any considerable amount of time upon experiments

of this character. I have, however, discussed graphically the material obtained through determinations of the focus, and find from 24 measured distances between 3″ and 14″, that the correction to the measured distance of the images is fairly well represented by the expression

$$Corr. = +0''.032\,(s - 6''.5)$$

Comparing this formula with the mean of the corrections relative to Dembowski, Hall and Burnham, I find

s.	2″.	3″.	4″.	5″.	6″.	7″.
⅓(D. + B. + H.)	−0″.13	−0″.11	−0″.07	−0″.03	+0″.01	+0″.05
Formula.	−0 .14	−0 .11	−0 .08	−0 .05	−0 .02	+0 .02

which is a much closer agreement than could be well expected *à priori*, and leads me to regard the method as one deserving further investigation.

Probable Errors. In any discussion of the accuracy of the following observations the Struve stars should be treated separately, since being bright stars their observation is comparatively easy, while most of the remaining doubles contain at least one faint component and many of them are so far south that they were necessarily observed at great zenith distances. An inspection of the observations of the Struve stars will show that the distribution of their residuals does not conform very well to the theoretical distribution given by the Gaussian law of error, and probable errors computed from them are therefore entitled to but little confidence. I have nevertheless derived these probable errors as well as the corresponding probable errors for the remaining stars, and both are given in the following table, in which n denotes the number of residuals employed, m the number of stars, s the mean distance of the components of all the stars united into a single group, and r the probable error of a single observation, expressed in parts of a great circle. The probable errors have all been computed from the first powers of the residuals:

Limiting Distance.	s.	Position Angles.			Distances.		
		r.	n.	m.	r.	n.	m.
			General List.				
	″	″			″		
Under 1″	0.8	± 0.031	66	20	± 0.088	56	18
1″ to 3″	1.9	.049	415	130	.129	345	111
3 to 6	4.0	.088	195	60	.133	168	54
6 to 24	10.6	.192	59	18	.136	27	9
			Struve Stars.				
Under 3″	1.5	± 0.051	42	6	± 0.077	39	6
3″ to 8″	5.0	.090	38	4	.108	38	4

It appears from these probable errors that in general the position angles are more accurate than the distances; that the precision of the measured position angles of the Struve stars is approximately the same as for the other stars; and that the distance measures of the Struve stars are considerably more accurate than in the case of the other stars. The probable errors of the measures of position angles are very well represented by the formula:

$$r = \pm 0''.017\,(1 + s) = \pm 0^\circ.97\,(1 + \frac{1}{s})$$

where s is expressed in seconds.

In the following pages, which contain the results of observation, the coordinates of the stars are given for the epoch 1880.0. The "Corrected Distances" are obtained from the measured distances, s, by applying to the measures by method b the reduction to method a. The note, *X* inch, in the column of remarks indicates that the aperture of the telescope was reduced to ten inches. The mean epoch of the β observations which are compared with mine may be assumed to be 1881.5. The designations of the stars, W. O. followed by a numeral, refer to the serial numbers assigned to them in *Publications of the Washburn Observatory, Vols. 1 and 2.*

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 1, D. M. 53°, 25

R. A. = 0^h $8^m.2$ Dec. = +53° 10′.

1887.832	23.1	3.4	1.80	....	8.	10.5	II.	
8.736	21.2	8.2	2.47 a	2.47	8.5	11.5	II.	
8.744	21.3	11.0	2.21 b	2.66	8.5	11.5	I.	
8.955	3.1	5.1	2.11 b	2.57	8.	10.5	I.	Bad seeing.
1888.567		6.9		2.57	8.2	11.0		Motion (?) in p.
β		13.3		2.60	8.4	10.9		

β. 776, D. M. 49°, 40

R. A. = 0^h $10^m.9$ Dec. = +49° 55′.

1888.821	3.9	200.2	0.86 b	1.06	9.	9.5	II.	
8.914	5.5	202.8	....	....	8.5	9.	III.	
8.922	4.3	202.9	1.16 a	1.16	8.8	9.	III.	
1888.886		202.0		1.11	8.8	9.2		
β		202.5		0.90	8.8	9.0		

β. 777, D. M. −1°, 32

R. A. = 0^h $15^m.0$ Dec. = −0° 55′.

1887.859	1.7	166.9	3.93	3.93	8.5	9.5	V.	
8.695	0.9	167.6	4.02 a	4.02	9.	10.	II.	
8.739	23.4	164.2	2.82 b	....	8.5	10.	II.	Through clouds.
1888.323		166.2		3.98	8.7	9.8		
β		166.7		4.07	8.5	9.5		

W. O. 2, O. Arg. 323

R. A. = 0h 18m. 8 Dec. = + 50° 54′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.736	21.5	332.7	2.59 a	2.59	9.	9.1	II.	
8.739	21.4	329.8	2.10 b	2.62	9.5	9.5	II.	
8.744	21.6	329.3	2.77 a	2.77	9.	9.	I.	
8.744	22.3	331.6	2.70 a	2.70	9.4	9.5	I.	
1888.741		330.8		2.67	9.2	9.3		
β		332.1		2.43	8.8	8.8		

β. 778, D. M. 51°, 72′

R. A. = 0h 19m.7 Dec. = + 51° 10′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.768	22.9	43.6	1.28	1.28	9.	9.2	III.	
7.781	22.2	47.9	1.08	1.08	9.	9.	II.	
8.955	2.8	223.3	......	....	9.5	9.6	III.	X inch.
8.966	1.7	45.3	0.94 b	1.35	9.5	9.5	III.	Diffuse.
1888.368		45.0		1.24	9.2	9.3		
β		47.9		1.04	9.5	9.5		

β. 779, L1. 592

R. A. = 0h 21.6 Dec. = + 22° 55′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.757	23.2	265.2	0.87	0.87	8.	9.	III.	
7.859	2.0	258.8	0.73	0.73	8.5	9.	V.	
8.966	2.1	257.3	0.71 b	1.02	8.8	9.5	III.	X inch.
1887.861		260.4		0.87	8.4	9.2		
β		263.3		0.85	8.5	9.0		

β. 780, D. M. 36°, 79

R. A. = 0^h $26^m.0$ Dec. = + 39°, 5′

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.757	23.6	138.6	2.55	2.55	8.	9.5	III.	
7.947	4.0	146.7	....	....	8.5	10.5	V.	
8.733	21.2	141.5	2.05 b	2.48	8.5	10.	I.	
8.821	4.2	144.9	2.38 a	2.38	9.	10.5	II.	
8.936	5.4	146.4	2.39 a	2.39	8.	10.	I.	X inch.
8.944	2.5	143.8	2.49 a	2.49	8.5	10.5	I.	
1888.523		143.6		2.46	8.4	10.2		
β		144.2		2.31	8.5	9.8		

W. O. 61, W. B. 0., 468

R. A. = 0^h $29^m.0$ Dec., = + 14° 13′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.763	23.7	225.0	1.21 b	1.53	9.5	11	II.	
8.769	23.2	227.8	1.37 b	1.74	9.5	11	II.	
8.772	23.3	222.4	1.23 b	1.56	9.5	11.5	II.	
1888.768		225.1		1.61	9.5	11.2		

W. O. 3, D. M. 52°, 158

R. A. = 0^h $38^m.4$ Dec. = + 52° 54′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.733	22.2	51.7	3.20 a	3.20	9.	9.3	I.	
8.739	21.7	54.2	2.37 b	2.91	9.	9.5	II.	
8.744	21.9	52.3	3.31 a	3.31	8.7	9.	I.	
1888.739		52.7		3.14	8.9	9.4		Motion (?) in *s*.
β		54.5		2.64	8.5	8.6		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 781, L1. 1337

R. A. = 0h 44m.0 Dec. = + 68° 20′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.760	23.1	26.1	1.04	1.04	8.	9.2	V.	
8.782	22.7	26.3	1.00 a	1.00	8.5	9.	V.	
8.791	23.7	27.2	1.07 a	1.07	8.5	9.5	V.	
1888.444		26.5		1.04	8.3	9.2		Motion (?).
β		31.2		1.03	8.1	8.6		

Σ 65,

R. A. = 0h 45m.1 Dec. = + 68° 12′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.782	22.5	37.3	3.08 a	3.08	8.5,	8.5	V.	
Σ 1832		35.1		2.99	8.0,	8.0		

W. O. 4, D. M. 53°, 184

R. A. = 0h 50m.6 Dec. = + 53°, 45′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.821	3.7	123.7	0.94 b	1.18	8.5,	9.5	II.	
8.865	23.6	122.3	0.98 b	1.28	9.	9.5	V.	
8.895	4.7	124.9	0.89 b	1.30	8.	11.5	III.	X inch.
1888.860		123.6		1.25	8.5,	10.2		
β		125.0		0.97	8.5,	9.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				

W. O. 62, Anon.

R. A.=0h 56m.1 Dec. = − 9° 30′.

1888.763	23.9	294.4	......	....	10.	10.	II.	
8.769	23.5	290.3	0.96 b	1.17	10.	10.	II.	
8.782	22.3	288.4	1.51 a	1.51	10.	10.	V.	
8.859	2.2	291.0	1.06 a	1.06	10.	10.	V.	
1888.794		291.0		1.25	10.0	10.0		

W. O. 5, D. M. 27°, 167

R. A. = 0h 57m.5 Dec. = + 27° 8′.

1888.733	22.7	173.3	2.42 b	2.90	9.	12.	I.	
8.736	20.4	176.4	2.45 b	2.98	9.	12.	II.	
8.739	22.4	176.5	3.03 b	3.58	9.	12.	II.	
1888.736		175.4		3.15	9.	12.		
β		179.0		2.98	8.6	11.5		

β. 782, L1. 2357

R.A. =1h 13m.3 Dec. = + 55° 35′.

1887.760	23.4	76.2	3.10	3.10	8.	9.3	III.	
8.733	21.6	76.5	3.08 a	3.08	8.	9.3	I.	
8.739	22.9	77.3	3.31 a	3.31	8.	9.5	II.	
1888.411		76.7		3.16	8.0	9.4		
β		79.2		2.94	8.0	9.6		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 6, W. B. 1, 612

R. A. = 1h 29m.1 Dec. = + 32° 26′.

1887.947	3.8	108.2	2.33	2.33	8.5	8.5	V.	
8.128	5.8	106.2	1.81 b	2.18	8.5	9.	I.	
8.736	20.8	286.1	2.11 a	2.11	9.	9.2	II.	
1888.270		106.8		2.21	8.7	8.9		
β		108.3		2.13	9.1	9.1		

β. 783, O. Arg., 1777

R. A. = 1h 52m.4 Dec. = + 73° 56′.

1888.791	23.9	314.1	0.95 a	0.95	9.	10.	III.	
8.826	23.4	315.6	0.73 b	1.05	9.	9.8	III.	
8.848	23.0	316.8	0.89 a	0.89	9.	10.	III.	
1888.822		315.5		0.96	9.0	9.9		
β		318.0		0.93	8.5	8.9		

β. 784, D. M. 22°, 269

R. A. = 1h 39m.6 Dec. = + 22° 20′.

1887.757	23.9	46.0	2.42	2.42	8.5	9.5	III.	
7 760	23.7	49.5	2.02	2.02	8.5	9.5	III.	
7.859	2.4	48.2	2.04	2.04	9.	9.5	V.	
1887.792		47.9		2.16	8.7	9.5		
		46.7		1.85	8.9	9.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

Σ. 170,

R. A. = 1h 45m.6 Dec. = + 76° 2′.

1888.791	1.1	248.8	3.40 a	3.40	8.	8.5	V.	
8.802	3.2	246.6	3.32 a	3.32	7.	8.	V.	
8.813	23.1	246.0	3.53 a	3.53	8.	8.7	V.	
8.922	2.3	248.9	3.17 a	3.17	7.5	8.	V.	
8.966	4.8	248.9	3.55 a	3.55	...	...	V.	
9.044	5.6	247.5	3.25 a	3.25	7.5	8.5	V.	
9.060	6.8	244.9	3.36 a	3.36	7.	7.5	V.	X inch.
9.192	10.0	245.4	3.21 a	3.21	7.5	8.5	V.	
9.219	10.1	245.9	3.21 a	3.21	7.	8.	V.	
9.222	8.8	246.4	3.39 a	3.39	7.	8.	V.	
9.586	20.5	246.1	3.47 a	3.47	7.	8.	V.	
1889.056		246.9		3.35	7.3	8.2		

Σ. 191,

R. A. = 1h 53m.7 Dec. = + 73° 20′.

1888.791	1.3	193.6	5.50 a	5.50	6.5	8.5	V.	
8.802	3.4	191.7	5.32 a	5.32	6.5	8.5	II.	
8.813	23.4	193.1	5.44 a	5.44	6.5	8.5	II.	
8.922	2.5	193.7	5.31 a	5.31	7.5	9.	V.	
9.006	4.3	193.8	5.47 a	5.47	6.	8.	V.	X inch.
9.044	5 9	192.4	5.34 a	5.34	7.	9.	V.	
9.060	7.0	192.9	5.39 a	5.39	6.	8.5	V.	X inch.
9.192	9.6	192.1	5.68 a	5.68	7.	9.	V.	
9.222	10.0	191.7	5.62 a	5.62	6.	8.	V.	
9.227	8.5	193.7	5.50 a	5.50	7.	9.	V.	
1889.008		192.9		5.46	6.6	8.6		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 785, 49 Cassiop.

R. A. = 1h 54m.1 Dec. = + 75° 32′.

1888.791	0.2	250.2	5.04 a	5.04	..	13.	I.	
8.826	23.7	246.8	5.34 a	5.34	6.	13.	I.	
8.848	23.4	243.7	5.00 a	5.00	6.	13.	I.	Difficult.
8.865	22.9	248.6	5.15 a	5.15	6.	13.	I.	
1888.832		247.3		5.13	6.0	13.0		
β		245.7		5.20	6.0	13.0		

β. 786, D. M. 55°, 563

R. A. = 2h 9m.3 Dec. = + 55° 12′.

1887.781	0.1	350.5	5.37	5.37	8.	10.	II.	
8.102	7.0	347.9	5.29 a	5.29	8.	9.	V.	
8.304	10.0	350.8	5.23 a	5.23	8.5	10.	I.	
1888.062		349.7		5.30	8.2	9.7		Motion.
β		353.0		4.87	8.5	9.9		

Σ 235, D. M. 55°, 566

R. A. = 2h 9m.6 Dec. = + 55° 18′.

1887.781	23.2	46.2	1.94	1.94	8.8	9.2	II.	Cf. Σ. and Δ. constant position angle and slowly increasing distance.
8.815	23.6	44.6	1.90 a	1.90	9.	9.	III.	
1888.298		45.4		1.92	8.9	9.1		

W. O. 7. L1. 4370

R. A. = 2h. 16m.8 Dec. = + 57° 40′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.760	0.9	186.0	2.17	2.17	8.	9.3	III.	
7.832	23.4	181.1	2.51	2.51	8.5	9.5	II.	
8.739	22.0	186.0	2.17 b	2.69	8.5	10.	II.	
90.096	7.9	188.1	1.97 a	1.97	8.	10.	III.	Good observation.
0.099	5.0	188.0	2.02 a	2.02	8.	9.5	III.	
1889.052		185.8		2.27	8.2	9.7		Motion (?).
β		186.5		1.78	8.1	10.4		

W.O. 63, D. M. 11°, 355

R. A. = 2h 27m.9 Dec. = +11° 18′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.077	3.8	289.1	0.91 b	1.10	9.	9.5	V.	
8.082	4.6	287.9	0.84 b	1.22	9.	9.2	III.	
8.102	5.0	289.9	0.82 b	1.18	9.	9.5	III.	
1888.087		289.0		1.17	9.0	9.4		

W. O. 64, D. M. + 1°, 456

R. A. = 2h 39m.3 Dec. = + 1° 8′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	3.8	215.1	5.16 a	5.16	8.5	11.	I.	
8.077	4.0	214.9	4.73 a	4.73	8.5	11.5	V.	
8.082	4.9	212.8	......	....	8.	12.5	III.	Seen through fog.
8.922	0.8	217.4	4.62 a	4.62	8.	13.	I.	Diffuse.
1888.289		215.0		4.84	8.2	12.0		

W O. 8, D. M. 49° 950

R. A. = 3h 22m.0 Dec. = + 49° 22′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.757	0.4	174.9	2.49	2.49	8.	8.5	III.	
7.760	0.8	176.2	2.41	2.41	8.	8.5	III.	
8.128	6.1	175.6	2.68 a	2.68	8.5	9.	I.	
1887.882		175.6		2.53	8.2	8.7		Motion in *s*.
β		176.7		1.89	8.4	8.8		

W. O. 65, S. D. 6°, 692

R. A. = 3h 25m.4 Dec. = − 6° 6′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	4.2	2.9	3.77 a	3.77	9.	9.3	V.	
8.077	4.3	2.9	3.97 a	3.97	9.5	10.	V.	
8.082	5.1	5.6	......	....	9.8	10.	III.	Through fog.
1888.078		3.8		3.87	9.4	9.8		

β. 787, Ll. 6473

R. A. = 3h 25m.6 Dec. = + 48° 13′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.781	0.3	237.3	1.53	1.96	8.	12.	II.	
8.200	7.7	230.1	......	....	8.	12.	V.	Very difficult.
8.791	0.4	232.3	......	....	8.	13.	I.	
8.944	1.4	242.2	1.89 a	1.89	8.	12.	II.	Good obs.
9.222	9.4	223.4	1.76 b	2.22	7.7	13.	II.	Very difficult.
1888.588		233.1		2.02	7.9	12.4		Motion in *p*.
β		228.5		2.04	8.0	12.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				

β 788, D. M. 42°, 786

R. A.$=3^h\ 27^m.2$ Dec.$=+42°\ 10'$.

A. B.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1887.781	0.9	303.9	2.77	2.77	8.5	10.	II.	
8.197	7.7	300.6	2.15 b	2.69	8.	10.	V.	
8.200	7.9	302.1	2.51 a	2.51	9.	10.5	V.	
1888.059		302.2		2.66	8.5	10.2		
β		306.2		2.77	8.3	10.5		

A. C.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1887.781	1.1	82.4	33.99	33.99	8.5	9.	II.	
8.197	7.8	82.4	34.00 a	34.00	8.	8.5	V.	
1887.989		82.4		34.00	8.5	8.8		
β		82.2		34.28	8.3	8.8		

W. O. 9, O. Arg. 3946

R. A.$=3^h\ 29^m.2$ Dec.$=+47°\ 43'$.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1887.757	0.7	61.5	1.77	1.77	8.	8.5	III.	
7.760	0.4	64.0	1.64	1.64	8.5	8.8	III.	
7.832	23.9	62.6	1.47	1.47	8.5	9.	II.	
8.128	6.4	60.3	1.67 b	2.01	8.5	9.	I.	
1887.868		62.1		1.72	8.4	8.8		Motion in *s*.
β		62.8		1.32	8.5	8.5		

W. O. 66, Ll. 7187

R. A. = 3^h $46^m.8$ Dec. = $-8°$ 51′.

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.074	4.6	31.9	2.42 b	[2.97]	8.	12.	V.	From a comparison of Lalande with Paris I find for proper motion of star, 0″.16 in the direction 102.° This would diminish the position angle about 4° per year and leave the distance unchanged.
8.077	4.6	32.7	2.45 b	[3.00]	8.	12.	V.	
8.859	2.7	28.3	2.42 a	2.42	8.	13.	I.	
8.966	4.1	32.5	2.10 a	2.10	8.	12.	I.	
90.070	4.2	30.7	2.08 a	2.08	8.	12.5	V.	
1888.809		31.2		2.20	8.0	12.2		Motion ?

W. O. 67, Ll. 7249

R. A. = 3^h $48^m.9$ Dec. = $-13°$ 4′.

Date.	Sid. Time.	*p*	*s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	5.1	160.6	2.92 a	2.92	8.	9.	V.	
8.077	4.8	157.9	3.42 a	3.42	8.	9.	V.	
8.859	3.0	154.5	3.01 a	3.01	8.5	9.	V.	
1888.337		157.7		3.12	8.2	9.0		

W. O. 68, Anon.

R. A. = 3^h $49^m.8$ Dec. = $-17°$ 19′.

Date.	Sid. Time.	*p*	*s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	5.8	178.0	7.48 b	....	10.	12.	V.	
8.859	3.3	177.8	8.96 a	8.96	10.	11.	II.	
8.966	3.3	178.4	8.76 a	8.76	10.	11.	I.	
1888.633		178.1		8.86	10.0	11.3		

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 69, D. M. 18°, 565

R. A. = $3^h 50^m.9$ Dec. = +18° 35′.

Date.	Sid. Time.	*p*	*s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.077	5.5	192.7	2.85 a	2.85	9.	9.5	V.	
8.102	5.8	190.7	1.70 b	2.26	9.	9.5	III.	
8.128	7.5	192.6	1.59 b	1.92	9.5	10.	I.	Seeing very bad.
1888.102		192.0		2.34	9.2	9.7		

W. O. 70, W. B. III, 996

R. A. = $3^h 52^m.2$ Dec. = −5° 15′.

Date.	Sid. Time.	*p*	*s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	6.0	270.5	3.55 a	3.55	8.5	9.	V.	
8.077	5.6	274.4	3.33 a	3.33	8.5	9.5	V.	
8.102	6.2	271.9	3.39 a	3.39	8.	9.	III.	
1888.084		272.3		3.42	8.3	9.2		

W. O. 71, W. B. III, 1005

R. A. = $3^h 52^m.4$ Dec. = −9° 15′.

Date.	Sid. Time.	*p*	*s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.077	5.8	151.5	4.10 b	....	8.5	13.	V.	
8.178	6.8	163.0	3.58 b	....	9.	11.5	V.	
8.859	3.6	157.0	4.05 a	4.05	9.	12.	I.	
1888.371		157.2		4.05	8.8	12.2		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 10, D. M. + 47°, 930

R. A. = 3^h $58^m.7$. Dec. = +48° 3′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.791	0.8	89.3	3.93 a	3.93	9.	10.	I.	Wrongly identified in Vol. 1.
8.826	1.2	87.9	4.21 a	4.21	..	....	I.	
8.865	23.9	88.6	4.18 a	4.18	9.	10.5	I.	
1888.827		88.6		4.12	9.0	10.2		
β		89.5		4.40				

W. O. 72, S. D. 9°, 806

R. A. = 3^h $59^m.1$ Dec. = — 9°, 4′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.074	6.5	33.7	1.70 b	2.20	10.	10.	V.	
8.077	6.1.	34.7	1.56 b	2.02	9.5	10.	V.	
8.137	6.9	30.8	1.56 b	1.88	10.5	10.5	I.	
1888.096		33.1		2.03	10.0	10.2		

β. 789, Ll. 8426

R. A. = 4^h $23^m.5$ Dec. = + 37° 24′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.197	7.4	322.0	1.05 b	1.37	8.	9.	V.	
8.200	8.1	322.4	1.21 a	1.21	8.5	9.	V.	
8.266	8.9	322.5	1.33 a	1.33	8.	9.	II.	
1888.221		322.3		1.30	8.2	9.0		
β		322.6		1.30	8.1	8.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 73, O. Arg., 3901

R. A. = 5^h $17^m.3$ Dec. = — 17°, 23′.

1888.137	6.6	48.7	2.43 b	....	9.	10.5	I.	
8.175	6.7	47.4	2.46 a	2.46	9.	10.5	V.	
8.178	7.1	50.6	2.39 a	2.39	9.	10.5	V.	
1888.163		48.9		2.42	9.0	10.5		

W. O. 74, S. D., 17°, 1109

R. A. = 5^h $18^m.0$ Dec. = — 17° 18′.

1888.077	6.4	234.4	......	....	9.5	10.	V.	
8.128	7.2	232.0	......	....	9.5	9.5	I.	Poor seeing.
8.137	6.4	233.2	4.85 b	....	9.	9.2	I.	
8.859	4.0	234.1	6.01 a	6.01	10.	10.	I.	
1888.300		233.4		6.01	9.5	9.7		

W. O. 75, S. D., 8°, 1126

R. A. = 5^h $21^m.9$ Dec. = — 8° 49′.

1888.128	7.0	91.1	......	....	9.	9.5	I.	Through clouds.
8.137	6.1	89.8	5.91 a	5.91	8.5	9.5	I.	
8.175	7.1	90.0	6.57 a	6.57	8.5	9.5	V.	
8.859	4.3	88.2	6.33 a	6.33	9.	10.	V.	
1888.325		89.8		6.27	8.8	9.6		

W. O. 76, S. D., 14°, 1171

R. A. = 5h 28m.6 Dec. = − 14° 27′.

A. B.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.175	7.4	218.5	......	....	10.	10.	V.	
8.200	9.0	218.8	.....	....	10.	10.	V.	By glimpses only.
8.859	4.6	218.4	2.97 a	2.97	10.	10.5	V.	
8.966	3.6	222.8	2.56 a	2.56	8.5	8.8	I.	
1888.550		219.6		2.76	9.6	9.8		

A. C.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.859	4.8	253.5	1.30 b	1.73	...	12.	V.	
8.966	3.8	251.0	1.56 b	1.88	...	12.	I.	
1888.912		252.2		1.80	9·6	12.0		

W. O. 77, Lamont 35

R. A. = 5h 39m.8 Dec. = — 15° 13′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.137	7.6	295.0	......	...	9.5	10.	I.	
8.175	7.8	291.3	1.77 a	1.77	10:	10.5	V.	
8.859	5.1	294.0	1.95 a	1.95	9.5	10.	V.	
1888.390		293.4		1 86	9.7	10.2		

W. O. 78, S. D., 12°, 1275

R. A.= 5h 43m.0 Dec. = − 12° 45′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.175	8.1	168.9	1.66 a	1.66	9.	9.2	V.	
8.178	7.7	167.0	2.11 a	2.11	9.	9.2	V.	
8.197	8.6	167.3	1.32 b	1.75	9.	9.2	V.	
1888.183		167.7		1.84	9.0	9.2		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

South 503.

R. A. = 5h 49m.2 Dec. = + 13° 55′.

A. B.

1890.096	4.3	358.9	3.94 a	3.94	6.	7.5	III.	X inch.
0.099	2.7	359.1	3.92 a	3.92	..	...	III.	Daylight.
0.115	3.5	357.3	3.95 a	3.95	5.	7.	III.	Woolly.
0.125	5.2	359.6	3.96 a	3.96	7.	8.	III.	Through clouds.
0.187	5.2	359.3	......	...	..	...	III.	Bad seeing.
0.206	7.4	360.8	3.86 a	3.86	6.	8.	III.	
0.217	7.4	361.8	3.75 a	3.75	...	...	III.	Bad seeing.
0.230	7.6	361.4	3.81 a	3.81	...	...	IV.	Excellent.
0.244	9.1	361.1	3.82 a	3.82	...	...	III.	
1890.164		359.9		3.88	...	...		

A. C.

1890.230	7.8	162.5	20.44 a	20.44	...	10.5	III.	Excellent.
0.244	9.8	164.3	20.27 a	20.27	...	....	V.	
1890.237		163.4		20.36	...	....		

W. O. 79, S. D., 5°, 1592

R. A. = 6h 14m.2 Dec. = — 5° 57′.

1888.178	7.9	327.6	2.42 b	2.87	10.	12.	V.	
8.859	5.3	325.7	3.19 a	3.19	10.	11.5	V.	
1888.518		326.6		3.03	10.	11.8		

W. O. 80, S. D., 14°, 1511

R. A. = 6^h $31^m.7$ Dec. = − 14° 9′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				
1888.128	8.4	132.0	3.65 b	4.21	9.	9.	I.	
8.137	7.8	132.4	3.81 b	4.37	9.	9.	I.	
8.175	8.5	131.3	4.29 a	4.29	9.	9.	V.	
1888.147		131.9		4.29	9.0	9.0		

W. O. 173, S. D., 13°, 1584

R. A. = 6^h $32^m.8$ Dec. = − 13° 43′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.137	8.2	268.7	6.87 b	...	9.	11.	I.	

W. O. 81, S. D., 13°, 1587

R. A. = 6^h $33^m.5$ Dec. = − 13° 56′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.137	8.4	189.3	3.96 b	....	8.	11.	I.	
8.178	8.3	185.5	4.05 a	4.05	9.5	11.	V.	
8.859	6.0	186.2	4.16 a	4.16	9.	11.	V.	
1888.391		187.0		4.10	8.8	11.0		

W. O. 82, S. D., 11°, 1660

R. A. = 6^h $45^m.3$ Dec. = − 11° 38′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.178	8.5	224.1	1.39 b	1.82	9.	10.2	V.	
8.200	9.1	220.1	1.63 a	1.63	9.5	10.5	V.	
8.859	5.5	224.2	1.65 a	1.65	9.5	10.5	V.	
1888.412		222.8		1.70	9.3	10.4		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				
			W. O. 83, R. A. = 6h 45m.6		S. D., 11°, 1661 Dec. = —11° 17'.			
1888.178	8.7	165.8	3.44 a	3.44	9.5	9.5	V.	
8.200	9.4	167.4	2.79 a	2.79	9.5	9.5	V.	Good seeing.
8.859	5.7	164.8	3.10 a	3.10	10.	10.	V.	
1888.412		166.0		3.11	9.7	9.7		
			W. O. 84, R. A. = 6h 57m.7		S. D., 8°,1714 Dec. = — 8° 17'.			
1888.137	9.0	36.7	3.66 b	....	9.5	9.5	I.	
8.175	9.6	37.4	5.30 a	5.30	9.5	9.5	V.	
8.859	6.2	38.1	5.18 a	5.18	9.8	10.	V.	
1888.390		37.4		5.24	9.6	9.7		
			W. O. 85, R. A. = 7h 7m.6		S. D., 19° 1753 Dec. = —19° 41'.			
1888.178	9.2	198.3	1.51 b	2.05	10.	11.	III.	
8.252	9.0	198.0	2.40 b	2.93	10.5	11.	V.	
9.066	5.8	197.2	2.56 a	2.56	10.	12.	II.	
1888.499		197.8		2.51	10.2	11.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 86, Anon.

R. A. = 7^h $9^m.3$ Dec. = −25° 46′.

1888 175	10.0	280.1	......	....	10.	10.5	V.	
9.066	7.0	282.6	......	....	10.	11.	II.	
9.077	6.9	280.6	6.09 a	6 09	11.	12.	I.	
9.115	6.6	284.2	6.25 a	6.25	10.	11.	III.	
1888.858		281.9		6.17	10.2	11.1		

W. O. 87, S. D., 21", 1880

R. A. = 7^h $15^m.0$ Dec., = − 21° 39′.

1889.060	7.6	274.1	4.19 a	4.19	9.5	9.8	V.	Seeing bad.
9.066	6.9	272.8	4.40 a	4.40	8.7	9.	II.	Seeing bad.
9.077	6.4	273.5	4.60 a	4.60	9.	9.5	I.	Seeing fair.
1889.068		273.5		4.40	9.1	9.4		

W. O. 88, O. Arg., 6629

R. A. = 7^h $15^m.1$ Dec. = −22° 40′.

1889.060	....	....	......	....	....	....	....	Not found.
9.066	....	....	......	....	....	....	....	Not found.

Castor.

R. A. = 7^h $27^m.0$ Dec. = + 32° 2′.

1890.244	10.1	229.9	4.64 a	4.64	....	....	VIII.	X inch. Blazing.

W. O. 89, S. D., 16°, 2068

R. A. = 7h 33m.9 Dec. = − 16° 25′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				
1888.252	9.4	216.8	3.24 a	3.24	9.5	10.5	V.	
8.277	9.4	216.8	2.88 a	2.88	9.	10.5	V.	
9.066	6.0	220.2	2.72 a	2.72	9.	10.	II.	
1888.532		217.9		2.95	9.2	10.3		

W. O. 90, O. Arg., 7228

R. A. = 7h 35m.6 Dec. = − 16° 12′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.252	9.6	278.5	3.08 a	3.08	9.	9.1	V.	
8.277	9.7	278.7	2.30 b	2.77	9.	9.5	I.	
9.066	6.3	279.1	2.59 a	2.59	9.7	10.0	II.	
1888.532		278.8		2.81	9.2	9.5		

W. O. 91, O. Arg., 7245

R. A. = 7h 36m.0 Dec. = − 20° 4′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.178	9.5	213.0	1.30 b	1.82	9.	11.5	III.	
8.252	9.9	217.7	2.04 a	2.04	8.5	10.5	V.	
9.066	6.5	212.8	1.79 a	1.79	9.	11.	II.	
1888.499		214.5		1.88	8.8	11.0		

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 92, S. D., 16°, 2188

R. A. = $7^h\ 49^m.4$ Dec. = − 16° 20′.

1888.200	10.2	271.8	2.19 b	2.73	10.	12.	V.	
8.252	10.1	273.6	2.85 a	2.85	9.5	11.	V.	
8.277	10.9	268.1	2.17 b	2.62	9.	11.	I.	
1888.243		271.2		2.73	9.5	11.3		

W. O. 93, S. D., 10°, 2319

R. A. = $7^h\ 53^m.7$ Dec. = − 10° 8′.

1888.252	10.8	183.9	0.86 b	1.23	9.5	10.5	III.	
9.219	8.1	192.9	0.74 a	0.74	9.	10.	III.	
9.222	8.4	185.5	0.73 b	1.03	9.	10.	III.	
1888.898		187.4		1.00	9.2	10.2		

W. O. 94, Ll. 15649

R. A. = $7^h\ 54^m.2$ Dec. = − 13° 31′.

1888.266	9.8	279.0	3.09 a	3.09	8.5	11.	II.	
9.060	8.3	279.5	2.52 b	3.02	9.	11.	I.	Seeing bad.
9.066	7.4	279.3	3.19 a	3.19	8.5	11.	I.	Seeing poor.
1888.797		279.3		3.10	8.7	11.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

ζ Cancri.

R. A. = 8h 5m.3 Dec. = + 18° 0′.

A. B.

1890.244	10.5	37.1	0.98 a	0.98	...	...	VIII.	X inch.

B. C.

1890.244	10.7	130.0	5.45 a	5.45	...	...	VIII.	X inch.

W. O. 95, Anon.

R. A. = 8h 11m.1 Dec. = — 28° 25′.

1888.266	9.5	169.0	3.77 a	3.77	9.	9.5	II.	
9.077	7.4	168.5	3.99 a	3.99	9.	10.	I.	
9.173	8.6	166.7	3.45 a	3.45	9.	10.	II.	Seeing poor.
9.192	8.2	169.0	3.72 a	3.72	9.	10.	II.	Good obs.
1888.927		168.3		3.73	9.0	9.9		

W. O. 96, S. D., 22°, 2265

R. A. = 8h 20m.6 Dec. = — 22° 19′.

1888.266	10.1	342.6	3.13 a	3.13	10.	11.5	II.	
8.277	10.4	345.1	2.79 b	3.31	9.	12.	I.	
9.066	7.7	341.3	2.71 b	3.22	9.	10.5	I.	
1888.536		343.0		3.22	9.3	11.3		

W. O. 97, D. M., 14°, 1934

R. A. = 8^h $30^m.9$ Dec. = + 14° 40′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.266	10.6	62.5	3.87 b	....	11.	11.	II.	
8.277	11.2	65.1	5.29 a	5.29	11.	11.	II.	
8.280	11.0	71.9	5.30 a	5.30	11.	11.	I.	
8.282	9.6	64.0	5.47 a	5.47	11.	11.	I.	
1888.276		65.9		5.37	11.0	11.0		

W. O. 98, O. Arg., 9673

R. A. = 9^h $18^m.9$ Dec. = — 23° 17′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.197	10.0	170.0	3.11 a	3.11	9.	9.	V.	
8.266	10.9	174.6	1.97 b	2.48	11.	11.	II.	
9.175	9.2	172.4	1.74 b	2.11	9.5	9.5	I.	Bad seeing.
1888.546		172.3		2.57	9.8	9.8		

ω Leonis.

R. A. 9^h $22^m.0$. Dec. = + 9° 35′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1890.244	10.9	103.1	0.62 a	0.62	....	...	VIII.	X inch.
0.288	12.3	100.5	0.75 a	0.75	6.8	7.	VIII.	
1890.266		101.8		0.68	6.8	7.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 99, Arg. Gen. Cat., 13351

R. A. = 9h 42m.5 Dec. = − 27° 2′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.197	10.2	220.2	1.48 b	1.94	8.	10.	V.	
9.211	9.5	217.7	1.16 b	1.53	8.	10.	V.	X inch.
9.217	9.2	216.5	1.78 a	1.78	9.	11.	III.	
1888.875		218.1		1.75	8.3	10.3		

β. 790, W. B., X, 26

R. A. = 10h 4m.1 Dec. = − 12° 17′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.266	11.2	69.2	......	....	9.	11.	II.	
8.274	10.7	68.2	1.94 b	2.47	9.	10.5	V.	
9.217	10.0	68.9	2.18 a	2.18	9.	10.	III.	
9.222	10.8	73.5	1.43 b	1.88	9.	11.	V.	Very difficult.
1888.745		70.0		2.18	9.0	10.6		
β		67.9		2.16	8.6	10.1		

O. Σ. 215,

R. A. = 10h 9m.7 Dec. = + 18° 20′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1890.244	11.7	211.7	0.66 a	0.66	....	....	VIII.	X inch.
0.288	12.5	215.5	0.83 a	0.83	6.7	7.	VIII.	X inch. Good.
1890.266		213.6		0.74	6.7	7.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.	Eye-piece.	Remarks.
	h.	°	"	"			

W. O. 100, S. D. 17°, 3100

R. A. = 10^h $10^m.0$ Dec. = − 17° 50′.

1888.200	10.8	199.9	1.15 b	1.50	9.5 11.	V.	
9.211	9.8	200.3	1.05 b	1.38	10. 11.	V.	
9.217	9.4	198.7	1.41 a	1.41	9.5 11.	III.	
1888.876		199.6		1.43	9.7 11.0		

W. O. 101, O. Arg., 10498

R. A. = 10^h $11^m.1$ Dec. = − 20°4′.

1888.252	11.0	115.4	1.23 b	1.73	6. 10.	III.	
9.217	9.8	112.3	0.87 b	1.25	6. 9.5	III.	
1888.734		113.8		1.49	6.0 9.8		

γ Leonis.

R. A. = 10^h $13^m.3$ Dec. = + 20°, 27′.

1890.244	12.0	114.8	3.32 a	3.32	....	VIII.	X inch.
0.288	12.7	114.2	3.39 a	3.39	....	VII.	X inch. Good.
1890.266		114.5		3.36			

W. O. 102, S. D., 20°, 3148

R. A. = 10^h $14^m.2$ Dec. = − 20° 45′.

1888.197	11.0	174.6	1.15 b	1.51	10. 11.	V.	
9.211	10.6	172.7	0.96 b	1.23	10. 11.	V.	
9.217	10.5	172.7	1.28 a	1.28	9.5 10.3	III.	
1888.875		173.3		1.34	9.8 10.8		

W. O. 103, Lamont 158

R. A. = 10h 14m.8 Dec. = —15° 45′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				
1888.197	11.2	337.3	1.34 b	1.77	9.	9.5	V.	
8.280	11.5	336.8	1.43 a	1.43	9.5	10.5	I.	
9.211	10.7	336.6	1.22 b	1.54	9.2	9.8	II.	
1888.563		336.9		1.58	9.2	9.9		

W. O. 104, S. D. 15°, 3031

R. A. = 10h 14m.8 Dec. = —16° 7′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.197	11.4	15.3	3.03 a	3.03	10.	10.	V.	
8.280	11.7	16.3	3.62 a	3.62	10.	10.	I.	
8.293	9.8	13.0	......	....	10.	10.2	I.	
1888.257		14.9		3.32	10.0	10.1		

W. O. 105, O. Arg. 10588

R. A. = 10h 18m.0 Dec. = —19° 19′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.312	11.3	120.7	0.70 b	0.84	9.	10.	V.	
9.211	11.0	113.6	0.79 b	0.99	9.5	10.5	V.	
9.217	10.7	115.4	0.91 a	0.91	10.	11.	III.	
1888.913		116.6		0.91	9.5	10.5		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

B. A. C. 3598,

R. A. = 10h 24m.1 Dec. = − 30° 0′.

1890.244	11.3	226.0	10.71 a	10.71	....	....	VIII.	X inch. See Flammarion, *Catalogue des Étoiles Doubles.*

W. O. 107, S. D. 17°, 3186

R. A. = 10h 29m.7 Dec. = − 17° 19′.

1888.312	10.0	309.3	1.61 a	1.61	10.5	11.	V.	
9.211	11.2	307.5	1.30 b	1.72	10.5	11.	V.	
9.217	10.9	310.3	1.46 a	1.46	10.	10.5	III.	
1888.913		309.0		1.60	10.3	10.8		

W. O. 108, B. B. vi, 63.

R. A. 10h 33m.3 Dec. = − 16° 57′.

1888.312	9.7	19.8	0.99 a	0.99	8.	9.	V.	
8.312	10.7	20.5	0.77 b	0.94	9.	10.	V.	
9.211	11.5	24.2	0.82 b	1.18	9.	10.	III.	
1888.612		21.5		1.04	8.7	9.7		

W. O. 11, Anon.

R. A. = 10h 36m.2 Dec. = − 2° 15′.

1888.389	Star not found.							Not in S. D.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 109, O. Arg., 10830.

R. A. = 10^h $37^m.4$ Dec. = — 20° 24′.

1888.312	10.5	142.4	1.93 a	1.93	10.	10.2	V.	
9.211	11.7	143.1	1.46 b	1.86	10.	10.	II.	
9.217	11.2	139.9	1.80 a	1.80	11.	11.	III.	
1888.913		141.8		1.86	10.3	10.4		

W. O. 110, O. Arg., 10860–1

R. A. 10^h $40^m.0$ Dec.= — 19° 5′.

1888.280	11.9	275.0	2.05 a	2.05	9.5	10.5	I.	
8.304	10.5	273.6	....	....	9.	10.	I.	
8.312	10.1	275.2	2.05 a	2.05	9.	10.	V.	
1888.299		274.6		2.05	9.2	10.2		

W. O. 111, S. D., 17°, 3257 ?

R. A. = 10^h $49^m.6$ Dec. = — 17° 40′.

1888.312	11.6	68.3	....	....	8.5	12.	V.	
9.211	12.0	69.7	5.10 a	5.10	9.	10.	II.	
1888.761		69.0		5.10	8.8	11.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 791, W. B., XI, 197

R. A. 11h 13m.4 Dec. = + 7° 32′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.370	11.8	198.8	2.19 a	2.19	8.5	10.5	V.	
8.381	11.4	196.9	1.77 b	2.24	8.5	10.	II.	
8.408	13.0	199.8	2.20 a	2.20	8.5	9.5	V.	
1888.386		198.5		2.21	8.5	10.0		
β		199.9		2.05	8.3	10.3		

β. 792, Schj., 4219

R. A. = 11h 35m.5 Dec. = + 3°, 33′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.274	11.2	196.5	1.63 b	2.12	8.5	11.	V.	
8.367	....	200.6	1.87 a	1.87	8.5	11.	V.	
8.370	12.0	198.1	1.83 a	1.83	8.	11.	V.	
8.408	13.5	201.4	1.95 a	1.95	8.	11.5	V.	
1888.355		199.2		1.94	8.2	11.1		
β		204.5		1.91	8.3	11.0		

β. 793, D. M., 7°, 2474

R. A. = 11h 37m.4 Dec. = + 7° 14′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.274	11.6	112.8	1.11 b	1.44	9.	11.	V.	
8.370	12.4	113.6	1.47 b	1.88	9.5	10.5	II.	
8.408	13.3	112.8	......	....	9.	11.	III.	
1888.351		113.1		1.66	9.2	10.8		
β		114.2		1.31	9.6	10.3		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 794, O. Arg., 12149

R. A = 11h 47m.2 Dec. = + 74° 26′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.397	12.9	129.6	0.42 b	0.42	7.5	8.5	IV.	
89.441	13.3	130.2	Elongated	....	...	...	VI.	
89.460	14.1	133.9	Elongated	....	...	...	VII.	
89.463	14.1	129.0	0.4 est.	0.40	...	...	VI.	
90.070	5.0	143.7	Elongated	....	...	...	VIII.	
1889.366		133.3		0.41	7.5	8.5		Rapid motion.
β		106.6		0.42	6.5	7.8		

W. O. 113, S. D., 13°, 3466

R. A. = 11h 47m.8 Dec. = — 13° 43′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.280	12.2	267.4	2.89 a	2.89	9.8	10.	I.	
9.211	12.2	268.1	2.71 a	2.71	9.	9.3	II.	
9.217	11.7	266.2	2.72 a	2.72	9.	9.5	III.	Fine definition.
1888.903		267.2		2.77	9.3	9.6		

β 795, Radcliffe, 2778

R. A. = 11h 53m.8 Dec. = + 71° 20′

A. B.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.280	10.4	151.4	33.91 a	33.91	8.	8.	I.	
β	....	150.9	....	33.43	7.7	7.7	..	

A. a.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.381	13.5	328.2	14.49 a	14.49	....	12.5	II.	
8.414	13.7	326.1	14.38 a	14.38	....	13.	VI.	
1888.398		327.2		14.44	8.	12.8		
β		327.0		13.76	7.7	13.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

B. b.

1888.280	10.0	112.5	5.27 a	5.27	....	12.5	I.	
8.312	11.8	117.8	......	...	....	12.5	V.	
8.381	13.5	117.7	5.88 a	5.88	....	12.	II.	
1888.324		116.0		5.58	8.	12.3		
β		116.2		5.75	7.7	12.5		

β 796. Ll. 23014

R. A. = 12h 11m.3 Dec. = + 7° 16′.

1888.397	13.3	278.4	0.35 b	0.57	8.	9.5	IV.	The corrections to the b measures perhaps ought not to be applied.
8.455	14.9	275.0	0.40 est.	0.40	9.	10.	IV.	
9.217	11.9	264.8	0.46 b	0.79	8.	9.	IV.	
1888.690		272.7		0.59	8.3	9.5		
β		270.9		0.31	8.0	8.8		

W. O. 12, D. M., — 1°, 2656

R. A. = 12h 15m.7. Dec. = — 1° 57′.

1888.389	12.3	93.1	0.96 b	1.21	8.5	10.	V.	
9.217	12.2	95.4	1.05 a	1.05	9.	10.	III.	
1888.803		94.2		1.13	8.8	10.0		
β		93.3		1.13	8.3	8.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	"	"				

W. O. 13, D. M. − 1°, 2666

R. A. = 12^h $20^m.3$ Dec. = − 1° 13′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.370	13.1	150.7	1.18 b	1.48	8.5	9.	II.	
8.373	15.0	150.1	......	....	...	...	II.	
8.389	12.7	153.9	1.54 a	1.54	9.	10.	V.	
8.397	15.1	153.4	1.47 a	1.47	8.5	8.8	V.	
1888.382		152.0		1.50	8.7	9.3		
β		153.2		1.39	8.1	8.4		

β. 797, D. M., 6°, 2630

R. A. = 12^h $28^m.4$ Dec. = + 6° 38′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.386	14.0	169.8	0.61 b	0.84	8.5	8.5	III.	
8.389	13.8	169.5	0.58 b	0.80	8.5	8.5	III.	
8.397	13.6	171.1	0.62 a	0.62	9.	9.	IV.	
1888.391		170.1		0.75	8.7	8.7		
β		171.2		0.73	8.5	8.6		

W. O. 117, D. M., 8°, 2644

R. A. = 12^h $43^m.1$ Dec. = + 8° 18′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.280	12.5	14.3	2.13 a	2.13	9.	10.	I.	
8.373	14.6	17.7	2.49 a	2.49	8.8	9.	I.	
8.436	15.7	18.5	2.55 a	2.55	9.5	9.5	III.	
1888.363		16.8		2.39	9.1	9.5		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 14, Lamont, 1121

R. A. = 12h 54m.6 Dec. = + 3° 31′.

1888.370	13.9	257.1	......	....	8.5	11.5	II.	
8.389	12.9	261.7	2.89 b	....	8.5	12.	V.	
8.397	15.8	257.6	2.70 a	2.70	8.5	11.5	V.	
9.271	12.5	259.1	3.11 a	3.11	9.	12.	III.	
1888.607		258.9		2.90	8.6	11.8		
β		262.2		2.80	8.3	10.5		

β. 799, Radcliffe, 2963

R. A. = 13h 1m.1 Dec. = + 73° 40′.

1888.397	12.4	241.9	0.35 b	0.55	6.	8.	VI.	
8.455	15.7	245.5	0.63 b	1.09	7.	8.5	IV.	
8.473	16.0	247.6	0.5 est.	0.50	..	...	VI.	
9.211	8.8	242.7	0.48 a	0.48	7.	9.	IV.	
1888.634		244.4		0.65	6.7	8.5		Motion ?.
β		238.7		0.57	6.5	8.5		

W. O. 174, S. D., 17°, 3774

R. A. = 13h 1m.4 Dec. = − 17° 21′.

1888.386	14.6	182.6	3.27 a	3.27	8.	12.	V.	

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 800, Comae, 201

R. A. = 13h 10m.8 Dec. = + 17° 40′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.381	14.8	117.7	2.11 a	2.11	7.	10.	V.	
88.389	14.0	116.5	2.07 b	....	6.5	9.	III.	
88.397	14.3	120.9	2.63 a	2.63	7.	10.	VI.	
90.206	9.9	114.7	2.02 a	2.02	7.	9.5	III.	
90.244	9.8	115.5	1.93 a	1.93	7.	10.	III.	
1889.123		117.1		2.17	6.9	9.7		Rapid motion in s.
β		121.5		1.26	7.1	10.2		

W. O. 15. Ll., 25043

R. A. = 13h 26m.8 Dec. = — 1° 48′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.389	13.2	297.0	....	.....	7.	12.	V.	
8.411	13.8	296.0	15.96 a	15.96	7.5	12.	I.	
8.436	15.1	295.9	16.54 a	16.54	7.	11.	III.	
1888.412		296.3		16.25	7.2	11.7		
β		296.3		16.09	7.0	11.2		

β. 801, Ll., 25399.

R. A. = 13h 40m.7 Dec. = + 11° 26′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.381	15.2	326.3	2.63 a	2.63	8.5	10.5	V.	
8.386	14.9	326.5	2.70 a	2.70	8.5	10.5	V.	
8.408	13.9	326.8	2.66 a	2.66	8.5	10.5	V.	
1888.392		326.5		2.66	8.5	10.5		
β		328.0		2.75	8.1	10.9		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 802, D. M., 49°, 2245

R. A. = 13h 43m.8 Dec. = + 48° 57′.

1888.411	16.7	220.0	3.20 a	3.20	8.	12.	I.	
8.436	16.6	221.0	3.83 a	3.83	8.	11.5	V.	
8.473	16.3	222.8	3.93 a	3.93	8.	11.5	VI.	Poor observation.
1888.440		221.3		3.65	8.0	11.7		
β		223.9		3.41	7.8	11.0		

W O. 16, Ll., 25923

R. A. = 14h 2m.2 Dec. = — 2° 58′.

1888.370	14.2	214.9	3.05 a	3.05	8.5	8.8	I.	
8.373	15.3	214.8	3.18 a	3.18	8.5	9.	II.	
8.411	13.3	215.8	2.92 a	2.92	8.5	9.	I.	
1888.385		215.2		3.05	8.5	8.9		
β		218.3		3.08	8.4	8.6		

W. O. 17, S. D., 1°, 408

R. A. = 14h 4m.3 Dec. = — 2° 6′.

1888.370	14.4	243.3	4.48 a	4.48	8.5	9.	I.	
8.373	15.6	244.2	4.59 a	4.59	9.	10.	II.	
8.411	13.6	243.1	4.51 a	4.51	8.5	9.5	I.	
1888.385		243.5		4.53	8.7	9.5		
β		243.6		4.31	8.8	9.5		

β. 803, Ll., 25991

R. A. = 14h 4m.8. Dec. = —2° 6′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.381	15.6	217.5	5.61 a	5.61	8.	11.5	V.	
8.386	15.2	220.3	5.27 a	5.27	8.	12.	V.	
8.408	14.1	222.1	5.26 a	5.26	8.	12.	V.	
1888.392		220.0		5.38	8.0	11.8		Motion.
β		227.9		5.24	7.8	12.0		

W. O. 18, Ll., 26172

R. A. = 14h 12m.8 Dec. = —17° 58′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.370	14.6	356.9	3.61 b	....	7.5	11.	I.	
8.373	16.0	357.3	3.28 b	....	8.	11.	II.	
8.411	14.1	355.6	3.82 a	3.82	7.	11.	I.	
1888.385		356.6		3.82	7.5	11.0		
β		357.9		3.56	7.6	11.0		

β. 804, W. B. XIV, 558

R. A. = 14h 31m. 7 Dec. = —8° 9′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.381	16.2	162.5	......	....	9.	11.	V.	
8.386	15.5	156.5	1.10 b	1.43	8.5	10.5	V.	
9.460	14.4	159.4	1.36 a	1.36	8.	11.	III.	X inch.
1888.742		159.5		1.39	8.5	10.8		Motion.
		166.2		1.40	8.1	10.7		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β 805, O. Arg., 13799

R. A. = $14^{h.}$ $33^{m}.0$ Dec. = — 26° 38′.

A. B.

1888.408	14.9	133.6	23.19 a	23.19	7.5	11.	V.	
9.460	14.8	133.9	23.74 a	23.74	6.5	12.	II.	
1888.934		133.8		23.46	7.0	11.5		
β		135.4		24.00	7.2	13.		

A. C.

1888.408	14.7	42.0	123.45 a	123.45	7.5	9.	V.	
β	....	42.0	......	123.38	7.2	9.2		

C. D.

1888.408	15.0	244.7	......	....	9.	11.	V.	
9.460	14.7	241.5	1.99 a	1.99	9.5	11.5	III.	
1888.934		243.1		1.99	9.2	11.2		Motion (?)
β		239.7		1.98	9.2	11.7		

β. 807, Schj., 5216

R. A. = 14^{h} $36^{m}.6$ Dec. = — 6° 18′.

1888.397	15.8	235.9	1.22 a	1.22	8.5	9.5	III.	
8.471	16.1	237.9	1.21 a	1.21	8.5	9.5	III.	
8.520	16.7	237.9	1.14 a	1.14	8.5	10.	III.	
1888.463		237.2		1.19	8.5	9.7		
β		239.0		1.23	8.0	9.1		

W. O. 19, Anon.

R. A. = 14h 36m.8 Dec. = − 24° 44′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.411	14.5	195.5	1.20 b	1.52	10.	11.	II.	
8.455	16.3	195.1	1.77 a	1.77	9.5	10.	III.	
1888.433		195.3		1.64	9.8	10.5		
β		194.9		1.76	9.4	11.0		

W. O. 20, 5 Librae

R. A. = 14h 39m .4 Dec. = − 14° 57′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.373	16.2	240.5	2.74 b	....	7.	11.5	II.	
8.406	16.2	247.3	......	....	6.	12.	V.	
8.411	14.6	242.5	2.51 a	2.51	7.	11.	I.	
9.460	15.7	246.8	2.89 a	2.89	6.	11.	III.	
1888.662		244.3		2.70	6.5	11.4		Motion?
		249.8		2.69	6.3	11.0		

W. O. 120, Ll., 27090

R. A. = 14h 46m.8 Dec. = + 8° 16′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.411	16.9	222.1	24.74 a	24.74	8.	10.5	I.	
8.436	16.1	222.0	24.66 a	24.66	8.5	10.	III.	
8.520	17.4	222.2	24.54 a	24.54	8.	9.	III.	
1888.456		222.1		24.65	8.2	9.8		

W. O. 21, S. D., 14°, 4070

R. A. = 14h 49m.0 Dec. = — 14° 15′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.370	14.8	21.5	3.93 a	3.93	8.5	8.5	I.	
8.406	16.4	21.8	3.62 a	3.62	8.5	8.5	V.	
8.411	15.0	21.3	3.83 a	3.83	9.	9.	II.	
1888.396		21.5		3.79	8.7	8.7		
β		23.0		3.90	8.5	8.6		

β. 808, W. B., XIV, 950.

R. A. = 14h 51m.8 Dec. = – 8° 11′.

AB., C.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.414	14.4	125.4	93.70 a	93.70	8.5	9.	I.	
8.526	18.0	125.9	93.65 a	93.65	8.	8.2	V.	
8.597	17.8	125.4	94.23 a	94.23	8.7	9.	III.	
1888.512		125.6		93.86	8.4	8.7		
β		305.1		94.15	....	8.9		

W. O. 22, S. D., 19°. 4004

R. A. = 14h 55m.3 Dec. = — 19° 48′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.386	16.1	360.8	2.40 a	2.40	9.	10.	V.	
8.408	15.6	358.7	1.82 a	1.82	8.5	9.2	V.	
8.411	15.2	357.6	2.31 a	2.31	9.	10.	II.	
1888.402		359.0		2.18	8.8	9.7		
β		360.1		2.21	8.5	9.3		

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 23, W. B., XIV, 1163

R. A. = 15h 2m.8 Dec. = — 7° 48′.

1888.386	16.3	359.0	3.09 a	3.09	9.	9.5	V.	
8.406	16.7	360.9	3.27 a	3.27	8.5	9.	V.	
8.408	16.5	359.4	3.49 a	3.49	8.8	9.2	V.	
1888.400		359.8		3.28	8.8	9.2		
β		360.7		3.38	8.6	8.9		

β. 809, S. D., 22°, 3908

R. A. = 15h 3m.1 Dec. = — 22° 16′.

1888.397	16.0	120.2	1.82 a	1.82	8.	9.5	III.	
8.567	16.8	125.1	1.65 a	1.65	8.	9.5	III.	
8.570	17.0	125.1	1.78 a	1.78	8.5	11.	II.	
1888.511		123.5		1.75	8.2	10.0		Motion.
β		120.1		1.46	8.0	9.3		

W. O. 24, Anon.

R. A. = 15h 16m.1 Dec. = — 25° 30′.

1888.386	16.6	275.7	4.25 a	4.25	9.	9.	V.	
8.411	15.7	273.9	3.61 a	3.61	8.8	9.	II.	
8.414	14.7	273.3	3.67 a	3.67	8.8	9.	III.	
1888.404		274.3		3.84	8.9	9.0		
β		276.5		3.74	8.6	8.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 175, O. Arg., 14516

R. A. = 15h 17m.3 Dec. = — 25° 20′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.408	15.9	14.8	5.97 a	5.97	8.5	9.	II.	
8.411	15.9	14.2	6.02 a	6.02	9.	9.5	II.	
1888.410		14.5		6.00	8.8	9.2		

μ^2 Bootis.

R. A. = 15h 20m.0. Dec. = + 37° 47′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1890.244	12.3	97.5	0.57 a	0.57	....	...	VIII.	X inch. Diffuse.
0.299	12.0	97.2	0.76 a	0.76	....	....	VII.	X inch. Diffuse.
1890.272		97.4		0.66	....	....		

W. O. 122, Lamont 1868

R. A. = 15h 28m.4 Dec. = — 10° 7′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1889.455	17.2	343.6	2.39 a	2.39	9.	10.	III.	
9.460	15.9	342.0	2.21 a	2.21	9.8	10.5	III.	
1889.458		342.8		2.30	9.4	10.2		

W. O. 25, S. D., 14°, 4256

R. A. = 15h 33m.6 Dec. = — 14° 8′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.397	16.7	312.2	1.49 a	1.49	8.8	9.	III.	
8.455	16.6	311.0	1.32 a	1.32	9.5	9.5	III.	
8.562	17.1	312.2	1.46 a	1.46	8.8	9.	V.	
1888.471		311.8		1.42	9.0	9.2		
β		313.8		1.23	8.8	9.1		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				

W. O. 123, S. D., 21°, 4176

R. A. = 15^h $35^m.9$ Dec. = —21° 32′.

1889.455	16.9	122.3	2.38 a	2.38	8.3	9.	III.	
9.460	16.1	121.2	2.55 a	2.55	9.5	10.	III.	
1889.458		121.8		2.46	8.9	9.5		

β. 810, W. B., XV., 1156

R. A. = 15^h $46^m.9$ Dec. = + 42° 50′.

1888.458	18.0	91.7	0.84 b	1.21	9.	12.	III.	
8.520	19.1	91.0	1.00 b	1.55	8.8	13.	IV.	
8.567	20.5	91.9	1.28 a	1.28	9.	11.5	III.	
1888.515		91.5		1.35	8.9	12.2		
β		93.2		1.08	8.5	11.2		

W. O. 125, S. D., 19°, 4276

R. A. = 15^h $53^m.0$ Dec. = — 20° 4′.

1889.455	16.5	286.5	3.14 a	3.14	8.8	9.	II.	X inch.
9.460	16.4	289.7	3.18 a	3.18	9.8	10.	III.	
9.520	16.4	290.9	2.87 a	2.87	10.	10.5	II.	X inch.
1889.478		289.0		3.06	9.5	10.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.	Eye-piece.	Remarks.
	h.	°	″	″			

W. O. 126, S. D., 20°, 4379

R. A. = 15^h $53^m.6$ Dec. = −20° 6′.

1889.455	16.6	38.3	2.32 a	2.32	8.	11.	II.	X inch.
9.460	16.2	33.1	2.30 a	2.30	10.	11.	III.	
1889.458		35.7		2.31	9.0	11.0		

W. O. 127, S. D., 20°, 4395

R. A. = 15^h $58^m.4$ Dec. = −20° 10′.

1889.455	16.3	131.3	2.05 a	2.05	8.	11.	II.	X inch.
9.460	16.6	130.9	1.96 a	1.96	10.	12.	III.	
1889.458		131.1		2.00	9.0	11.5		

β. 811, Ll., 29349

R. A. = 16^h $0^m.4$ Dec. = + 22° 18′.

1888.526	18.8	218.5	2.94 b	....	8.5	12.	III.	
8.545	20.0	218.4	3.82 a	3.82	8.5	12.5	III.	
8.567	20.9	218.4	3.75 a	3.75	8.5	12.	I.	
8.597	18.2	220.7	3.71 a	3.71	8.5	11.5	III.	
1888.559		219.0		3.76	8.5	12.0		
β		221.6		3.47	8.1	12.1		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

Σ 2084.

R. A. = 16h 1m.6 Dec. = + 88° 56′.

1888.802	1.6	115.5	1.18 a	1.18	7.5	8.	III.	
89.586	21.1	114.7	1.30 a	1.30	7.8	8.3	V.	
89.636	21.4	114.4	1.43 a	1.43	8.3	8.5	IV.	
90.096	8.7	114.8	1.25 a	1.25	7.5	7.8	IV.	X inch.
90.206	9.4	117.0	1.27 a	1.27	7.7	8.	VIII.	
1889.665		115.3		1.29	7.8	8.1		

β. 812, W. B., XVI, 1553

R. A. = 16h 1m.7 Dec. = + 17° 13′.

1888.389	14.6	126.7	0.64 b	0.87	8.5	8.5	III.	
8.455	17.3	122.4	0.70 a	0.70	9.	9.5	IV.	
8.520	18.0	126.5	0.70 a	0.70	8.5	9.	VI.	
1888.455		125.2		0.76	8.7	9.0		
β		127.4		0.87	8.2	8.3		

W. O. 128, O. Arg., 15527

R. A. = 16h 13m.3 Dec. = — 18° 7′.

1888.416	17.1	251.5	2.21 a	2.21	9.	10.	V.	
9.455	16.4	246.3	2.16 a	2.16	9.	10.3	III.	
9.460	16.8	248.7	1.84 a	1.84	9.	10.	III.	
1889.110		248.8		2.07	9.0	10.1		

W. O. 129, S. D., 17°, 4564

R. A. = 16h 17m.8 Dec. = − 18° 3′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.416	17.3	124.4	2.54 a	2.54	9.	10.	I.	The declination of this star given in Vol. II. is wrong.
9 460	17.4	124.2	2.42 a	2.42	11.	12.	III.	
9.583	18.0	124.2	2.79 a	2.79	9.5	11.	II.	
1889.153		124.3		2.59	9.8	11.0		

W. O. 130, S. D., 18°, 4283

R. A. = 16h 19m.5 Dec. = − 18° 13′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1889.460	17.0	0.3	1.13 a	1.13	10.	10.	III.	

β. 813 W. B., XVI, 661

R. A. = 16h 23m.0 Dec. = + 26° 48′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.389	15.3	162.4	1.29 a	1.29	8.5	8.5	III.	
8.545	19.4	167.0	1.00 a	1.00	8.5	8.8	III.	
8.893	21.8	166.7	0.99 a	0.99	...	...	II.	
1888.609		165.4		1.09	8.5	8.6		
β		165.4		0.96	8.4	8.4		

Σ. 2049 D. M., 26°, 2845

R. A. = 16h 23m.0 Dec. = + 26° 15′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.520	18.3	208.4	1.26 a	1.26	8.	8.5	VI.	
8.545	19.7	209.7	1.29 a	1.29	8.	8.5	III.	
1888.532		209.0		1.28	8.0	8.5		

β. 814, W. B., XVI, 676

R. A. = 16^h $23^m.2$ Dec. = + 40° 9′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.520	....	.....	....	....	...	...	IV.	Elongated in $p = 140°$.
β		322.6	0.36	....	8.4	8.7		

β. 815, W. B., XVI, 686.

R. A. = 16^h $23^m.8$ Dec. = + 43° 11′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.523	20.4	342.1	7.15 a	7.15	8.	9.	V.	
8.545	19.2	343.0	7.50 a	7.50	8.3	10.5	III.	
8.551	19.0	344.0	7.62 a	7.62	8.5	10.5	V.	
90.206	10.4	343.6	7.41 a	7.41	7.5	10.	V.	
1888.956		343.2		7.42	8.1	10.0		Rapid motion in s.
β		348.4		6.39	8.1	10.4		

β. 816, 31 Herculis

R. A. = 16^h $27^m.0$ Dec. = + 33° 46′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.523	20.1	220.8	5.18 a	5.18	...	12.	I.	
8.545	18.8	221.6	5.31 a	5.31	6.5	11.5	III.	
8.551	19.4	221.2	5.45 a	5.45	8.	12.	V.	
1888.540		221.2		5.31	7.5	11.8		
β		224.1		4.95	6.2	11.8		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β 817, W. B., XVI, 796

R. A. = 16h 27m.5 Dec. = + 23° 29′.

1888.389	15.7	329.3	1.26 a	1.26	8.3	8.5	III.	
8.520	19.6	327.7	1.02 a	1.02	9.	9.	VI.	
8.545	18.5	325.8	1.14 a	1.14	8.5	8.5	III.	
1888.485		327.6		1.14	8.6	8.7		
β		147.0		1.13	8.2	8.2		

Σ 2061.

R. A. = 16h 28m.6 Dec. = + 31° 10′.

1888.545	20.3	24.6	2.53 a	2.53	8.	9.	III.	

β. 818, 32 Herculis

R. A. = 16h 28m.8 Dec. = +30° 45′.

1888.698	19.6	39.9	3.03 a	3.03	6.	13.5	I.	
9.460	15.3	33.1	3.32 a	3.32	7.	13.5	III.	
9.583	20.4	35.2	3.90 a	3.90	6.5	13.5	I.	
1889.247		36.1		3.42	6.5	13.5		
β		33.5		3.27	6.3	13.5		

β. 819, S. D., 4°, 4183

R. A. = 16h 30m.4 Dec. = — 4° 55′.

1888.548	17.9	232.4	1.30 b	1.82	8.5	11.5	III.	Difficult.
8.567	17.2	229.5	1.29 a	1.29	9.	12.	III.	
8.675	18.5	233.0	1.16 b	1.66	8.5	11.	III.	Difficult.
1888.597		231.8		1.59	8.7	11.5		
β		230.8		1.58	8.6	11.3		

W. O. 26, S. D., 5°, 4325

R. A. = 16h 31m.2 Dec. = — 5° 16′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes		Eye-piece.	Remarks
	h.	°	″	″				
1888.406	17.2	183.3	6.85 a	6.85	9.	9.	V.	
8.408	16.1	183.0	6.73 a	6.73	8.5	8.7	V.	
8.414	15.1	184.5	6.53 a	6.53	9.	9.	I.	
1888.409		183.6		6.70	8.8	8.9		
β		4.1		6.96	8.8	9.0		

β. 820, Ll., 30279

R. A. = 16h 33m.2. Dec. = — 2° 52′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes		Eye-piece.	Remarks
1888.397	16.3	233.7	4.16 a	4.16	7.5	9.	III.	
8.545	18.1	232.5	4.47 a	4.47	8.	10.	III.	
8.567	17.6	233.2	4.26 a	4.26	8.	9.5	III.	
1888.503		233.1		4.30	7.8	9.5		
β		237.6		4.22	8.0	9.5		

ζ Herculis.

R. A. = 16h 36m.8 Dec. = + 31° 49′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes		Eye-piece.	Remarks
1888.551	18.7	76.7	1.94 a	1.94	..	8.5	V.	
8.570	19.2	74.1	1.88 a	1.88	..	...	III.	VI inch.
8.597	18.6	72.0	1.81 a	1.81	..	8.	V.	
9.444	18.9	76.8	1.74 a	1.74	..	8.	V.	X inch.
9.583	19.7	70.1	1.57 a	1.57	..	7.	IV.	X inch.
9.586	18.7	70.4	1.79 a	1.79	..	7.5	III.	X inch.
9.636	20.7	70.5	1.57 a	1.57	..	...	IV.	X inch.
1888.573		74.3		1.88		8.0		
1889.562		72.0		1.67		...		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 821, D. M., 32°, 2799

R. A. = 16h 47m.2 Dec. = + 32° 3′.

1888.389	16.0	312.9	1.28 a	1.28	8.5	9.5	III.	
8.520	19.9	312.3	1.34 a	1.34	8.5	9.	VI.	
8.551	19.7	315.7	1.29 a	1.29	9.	10.	III.	
1888.487		313.6		1.30	8.7	9.5		
β		313.6		1.20	8.4	8.9		

W. O. 27, Ll., 30853

R. A. = 16h 52m.5 Dec. = − 13° 1′.

1888.406	17.7	133.3	4.73 a	4.73	8.5	9.5	I.	
8.408	16.3	133.9	4.89 a	4.89	8.5	9.5	V.	
8.414	15.3	132.8	......	....	8.5	9.5	I.	
8.562	17.3	134.4	4.83 a	4.83	8.5	9.	V.	
1888.448		133.6		4.82	8.5	9.4		
β		135.0		4.85	8.5	9.1		

β. 822, Herculis 198

R. A.= 16h 58m.6 Dec. = + 19° 51′.

1888.416	16.1	234.2	1.85 a	1.85	7.	11.	V.	
8.545	20.9	226.6	1.70 a	1.70	7.	10.	III.	
8.551	20.1	232.0	1.87 a	1.87	7.	9.	III.	
1888.502		230.9		1.81	7.0	10.0		Motion?
β		228.0		1.49	6.9	11.3		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 823, L1., 31107

R. A. = 17^h $0^m.5$ Dec. = + 0° 49′.

1888 389	16.3	355.1	0.89 b	1.29	8.5	9.5	III.	
8.397	16.9	356.1	1.29 a	1.29	8.5	9.5	III.	
8.455	18.2	360.2	1.00 a	1.00	8.5	9.5	III.	
1888.414		357.1		1.19	8.5	9.5		Motion (?)
β		353.9		1.03	8.2	9.2		

W. O. 132, Anon.

R. A. = 17^h $11^m.6$ Dec. = — 23° 52′.

1888.562	18.6	31.0	1.80 a	1.80	9.	10.	V.	
8.668	18.6	29.9	2.04 a	2.04	8.8	10.	V.	
8.675	19.2	29.2	2.03 a	2.03	9.	10.	II.	
1888.635		30.0		1.96	8.9	10.0		

W. O. 133, O. Arg., 16701

R. A. = 17^h $16^m.4$ Dec. = — 21° 36′.

1888.562	18.9	163.9	1.04 a	1.04	8.5	8.8	V.	
8.668	18.7	168.9	1.07 a	1.07	9.	9.5	V.	
8.675	18.9	165.1	1.37 a	1.37	9.	9.2	II.	
1888.635		166.0		1.16	8.8	9.2		

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 28, O. Arg., 16709

R. A. = $17^h\ 16^m.8$ Dec. = — 30° 25′.

1888.406	17.5	231.7	3.37 a	3.37	8.5	9.5	I.	
8.416	17.1	235.3	3.60 a	3.60	8.5	9.	II.	
8.455	16.9	231.4	3.56 a	3.56	8.5	9.	III.	
1888.426		232.8		3.51	8.5	9.2		
β		236.8		3.41	8.7	9.1		

W. O. 134, O. Arg., 16726

R. A. = $17^h\ 17^m.5$ Dec. = — 21° 20′.

1888.562	19.3	153.9	3.70 a	3.70	6.	12.	I.	Poor obs.
8.668	19.0	150.2	4.11 a	4.11	6.5	12.	I.	
9.460	17.7	146.5	4.35 a	4.35	6.	12.	II.	
9.583	18.7	147.0	3.76 a	3.76	....	12.	II.	
1889.063		149.4		3.98	6.2	12.		

W. O. 135, O. Arg., 16764–5

R. A. = $17^h\ 18^m.7$ Dec. = — 19° 11′.

Searched for on three nights and not found.

W. O. 29, O. Arg., 16893

R. A. = $17^h\ 24^m.6$ Dec. = — 30° 22′.

1888.562	17.6	229.0	1.37 a	1.37	8.5	8.8	V.	
8.592	17.6	229.6	1.97 a	1.97	8.5	9.	III.	
8.668	18.2	229.6	1.40 a	1.40	8.	8.5	V.	
1888.607		229.4		1.58	8.3	8.8		
β		230.2		1.34	7.9	8.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 30, L1., 32046
R. A. = 17h 30m.5 Dec. = — 23° 19′.

1888.563	17.8	112.3	3.31 a	3.31	8.5	9.	V.	
8.592	17.8	112.9	3.24 a	3.24	8.5	9.	III.	
8.605	19.3	109.9	3.48 a	3.48	8.	9.	II.	
1888.586		111.7		3.34	8.3	9.0		
		111.7		3.26	8.3	9.2		

W. O. 137, S. D., 18°, 4592
R. A. = 17h 31m.3 Dec. = — 19° 1′.

1888.668	19.6	255.6	......	......	10.	11.5	V.	Poor observation.

W. O. 31, S. D., 14°, 4712
R. A. = 17h 31m. 7 Dec. = — 14° 46′.

1888.592	18.1	333.4	1.85 a	1.85	9.8	10.	III.	
8.597	18.9	329.9	1.79 a	1.79	8.8	9.	V.	
8.605	18.9	332.7	2.07 a	2.07	8.8	9.	III.	
1888.598		332.0		1.90	9.1	9.3		Motion.
β		338.2		1.37	8.9	9.2		

W. O. 138, O. Arg., 17072
R. A. = 17h 34m.3 Dec. = — 17° 54′.

1888.668	19.7	271.4	1.93 a	1.93	9.	9.5	V.	
8.673	19.4	271.5	2.04 a	2.04	9.	9.5	II.	
8.681	19.5	273.4	1.82 b	2.21	9.	10.	I.	
1888.674		272.1		2.06	9.0	9.7		

β. 824, D. M., – 1°, 3400

R. A. = 17h 42m.6 Dec. = – 1° 45′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.455	18.4	352.5	0.46 b	0.59	9.	9.	IV.	
8.567	17.9	347.3	0.59 a	0.59	8.5	8.7	IV.	
8.570	18.1	347.9	0.87 a	0.87	9.	9.2	III.	
8.592	17.3	350.1	0.72 a	0.72	8.5	8.7	III.	
1888.546		349.4		0.69	8.8	8.9		
β		350.9		0.67	8.5	8.6		

W. O. 139, P., xvii, 276

R. A. = 17h 48m.2 Dec. = – 11° 37′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.551	18.3	154.9	3.71 a	3.71	7.	9.5	II.	
8.668	20.2	157.5	3.88 a	3.88	6.5	10.5	V.	
8.681	19.8	150.1	3.53 a	3.53	6.	11.	I.	
1888.633		154.2		3.71	6.5	10.3		

W. O. 140, Brux., 7286

R. A. = 17h 53m.9 Dec. = – 20° 47′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.673	19.8	263.4	2.15 a	2.15	8.5	9.6	II.	
8.681	20.2	266.2	2.20 a	2.20	9.	10.	I.	
8.701	19.6	267.3	2.22 a	2.22	9.	10.	I.	
1888.685		265.6		2.19	8.8	9.9		

W. O. 32, Anon.

R. A. = 17h 55m.2 Dec. = −27° 4′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.416	17.5	99.6	4.62 a	4.62	8.5	9.	II.	
8.562	18.2	98.2	4.88 a	4.88	8.3	9.	V.	
8.592	18.9	99.5	4.99 a	4.99	8.3	9.	III.	
1888.523		99.1		4.83	8.4	9.0		
β		101.5		4.52	8.0	8.8		

Σ. 2268

R. A. = 17h 58m.3 Dec. = + 25° 22′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.592	20.6	194.5	11.42 a	11.42	8.	11.	III.	
8.681	21.8	191.4	......	.....	8.	12.	I.	
8.698	19.2	193.3	11.62 a	11.62	8.	12.	II.	
1888.657		193.1		11.52	8.0	11.7		
β		197.7		11.36	8.4	13.0		

β. 825, Σ 2268 A. C.

R. A. = 17h 58m.3 Dec. = + 25° 22′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.592	20.3	211.7	20.17 a	20.17	8.	8.5	III.	
8.678	21.2	211.4	20.18 a	20.18	8.3	9.	I.	
8.681	21.8	210.9	20.12 a	20.12	8.	8.5	I.	
1888.650		211.3		20.16	8.1	8.7		
β		212.5		19.98	8.4	8.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

70 (*p*) OPHIUCHI

R. A. = 17^h $59^m.4$ Dec. = + 2° 32′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.406	15.6	351.5	2.20 a	2.20	....	8.	V.	
8.411	17.2	353.8	1.97 a	1.97	....	8.5	II.	
8.416	16.8	352.7	2.08 a	2.08	....	8.5	V.	
9.444	14.3	344.6	2.29 a	2.29	....	8.5	V.	Seeing poor. X inch.
9.460	18.1	344.9	2.12 a	2.12	....	....	III.	Beautiful definition.
9.463	16.0	345.7	2.13 a	2.13	....	....	II.	X inch.
9.526	17.7	347.4	2.39 a	2.39	....	....	V.	X inch.
9.636	20.3	346.1	1.97 a	1.97	....	....	IV.	X inch. Good.
1888.411		352.7		2.08				
1889.506		345.7		2.18				

β. 826, D. M., 9°, 3566

R. A. = 18^h $2^m.1$. Dec. = + 9° 45′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.795	21.4	344.4	0.89	0.89	9.5	9.5	V.	
7.797	21.2	336.8	0.54	0.54	9.5	9.5	V.	
8.570	18.4	337.2	0.69 a	0.69	10.	10.	III.	
1888.054		339.5		0.71	9.7	9.7		
β		341.1		0.60	9.6	9.7		

W. O. 141, O. Arg., 17868

R. A. = 18^h $7^m.0$ Dec. = — 23° 42′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.673	20.0	26.2	1.54 a	1.54	9.	10.	II.	
8.681	20.4	26.0	1.26 b	1.48	9.5	10.5	I.	
8.701	20.0	27.0	1.33 b	1.69	9.	10.	II.	
1888.685		26.4		1.57	9.2	10.2		

Date.	Sid. Time.	Observed. *p*	Observed. *s*	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 142, L1., 33492

R. A. = $18^h\ 8^m.0$ Dec. = — 11° 15′.

1888.701	20.2	245.7	1.06 b	1.39	9.7	10.	V.	
8.722	20.0	242.2	0.89 b	1.07	9.8	10.	II.	Seeing very bad.
8.739	19.9	241.8	0.89 b	1.07	10.	10.	II.	
1888.721		243.2		1.18	9.8	10.0		

W. O. 143, Lamont, 549

R. A. = $18^h\ 10^m.7$ Dec. = — 16° 54′.

1888.673	20.6	103.8	1.72 b	2.18	10.	11.	II.	
8.701	20.5	106.5	1.61 b	2.05	10.	11.	II.	
8.725	19.6	103.5	1.72 b	2.18	10.	11.	II.	Seeing poor.
8.739	20.3	102.9	1.82 b	2.30	10.	11.	II.	Seeing poor.
1888.710		104.2		2.18	10.0	11.0		

W. O. 144, Yarnall 7794

R. A. = $18^h\ 18^m.5$ Dec. = — 21° 6′.

1888.666	19.0	40.1	3.09 a	3.09	8.8	9.	I.	
8.701	20.7	38.3	3.17 a	3.17	9.	9.	II.	
8.725	19.8	38.7	2.93 a	2.93	9.	9.	II.	
8.739	20.6	39.5	2.59 b	3.10	9.2	9.2	I.	
1888.708		39.2		3.07	9.0	9.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.	Eye-piece.	Remarks.
	h.	°	"	"			

W. O. 145, Lamont 667

R. A. = 18h 35m.9 Dec. = − 15° 30′.

1888.760	20.0	59.8	0.97 a	0.97	10. 10.	II.	
8.769	20.7	58.6	0.94 b	1.20	10. 10.5	V.	
8.782	21.0	58.2	1.03 a	1.03	10. 10.5	V.	
1888.770		58.9		1.07	10.0 10.3		

W. O. 146, S. D., 17°, 5305 (?)

R. A. = 18h 37m.4 Dec. = − 17° 39′.

1888.733	20.0	193.1	1.56 b	2.04	10. 10.5	V.	
8.760	20.6	193.5	2.65 a	2.65	11. 11.	II.	
8.769	20.9	194.7	2.75 a	2.75	10.5 11.	V.	
1888.754		193.8		2.48	10.5 10.8		

W. O. 147, O. Arg., 18713

R. A. 18h 42m.8 Dec. = − 17° 2′.

1888.695	21.3	298.2	1.98 b	....	9. 11.5	I.	Seeing very poor.
8.769	21.2	294.9	1.70 a	1.70	9.5 10.3	V.	
8.782	21.4	293.7	1.59 b	1.92	9. 11.	I.	
1888.749		295.6		1.81	9.2 10.9		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 148, O. Arg., 18742

R. A. = 18h. 43m.9 Dec. = −16° 54′.

1888.772	21.4	19.3	......	....	9.	13.5	I.	
8.782	21.1	18.3	3.18 a	3.18	9.	13.	I.	
9.583	19.0	19.6	3.63 a	3.63	9.	12.	II.	
1889.044		19.1		3.40	9.0	12.8		

W. O. 33, Anon.

R. A. = 18h 55m.7 Dec. = −28° 49′.

1888.592	19.2	59.7	2.58 a	2.58	8.5	8.8	III.	
8.597	19.2	60.9	2.70 a	2.70	8.7	9.	V.	
9.605	19.7	61.3	2.51 a	2.51	8.5	8.7	II.	
1888.598		60.6		2.60	8.6	8.8		
β		59.1		2.41	8.3	8.4		

Σ 2452

R. A. = 18h 57m.2 Dec. = + 75° 38′.

1888.802	2.0	217.8	5.75 a	5.75	6.5	7.	III.	
8.813	23.9	218.7	5.72 a	5.72	7.	7.5	II.	
8.922	1.3	219.6	5.61 a	5.61	7.	7.5	V.	
9.006	3.9	219.4	5.65 a	5.65	6.5	7.2	V.	X inch.
9.044	6.3	218.9	5.60 a	5.60	7.	8.	V.	
9.060	5.0	218.5	5.63 a	5.63	6.5	7.5	V.	
9.192	9.4	217.8	5.66 a	5.66	5.	7.5	V.	
9.227	8.8	217.5	5.60 a	5.60	7.	8.	V.	
1889.008		218.5		5.65	6.6	7.5		

W. O. 84, Radcliffe, 4234

R. A. = $19^h\ 9^m.9$ Dec. = + 55° 6'.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				
1887.790	21.8	269.2	3.15	3.15	8.5	10.	VI.	
7.798	0.2	268.9	2.97	2.97	8.	9.	V.	
7.813	22.3	269.6	2.92	2.92	8.	9.5	III.	
1887.800		269.2		3.01	8.2	9.5		
		271.2		3.28	8.5	9.1		

W. O. 149. S. D., 18°, 5330

R. A. = $19^h\ 15^m.3$ Dec. = — 18° 37'.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.731	20.4	190.1	1.06 b	1.39	10.2	10.5	V.	
8.769	21.3	181.3	1.29 a	1.29	10.	10.	V.	
8.782	21.6	182.7	0.96 b	1.18	10.	10.	II.	Seeing bad.
1888.761		184.7		1.29	10.1	10.2		

W. O. 151, S. D., 18°, 5342

R. A. $19^h\ 16^m.9$ Dec. = — 18° 44'.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.744	20.3	189.8	0.96 b	1.07	10.	11.	I.	
8.769	21.7	192.1	1.08 b	1.41	10.	10.5	V.	
8.782	21.8	191.9	1.76 a	1.76	10.	11.	II.	
1888.765		191.3		1.41	10.0	10.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				
		W. O. 35, R. A. = 19h 17m.0		S. D., 18°, 5342 Dec. = − 18° 43′.				
1888.592	19.5	189.7	2.02 a	2.02	9.5	9.7	III.	
8.597	19.5	187.1	1.78 a	1.78	9.	9.2	III.	
8.605	19.9	189.2	1.78 a	1.78	9.	9.2	III.	
1888.598		188.7		1.86	9.2	9.4		Motion in *s*.
β		191.2		1.39	8.8	9.0		
		β. 827, R. A. = 19h 38m.0		L1. 37470 Dec. = − 11° 29′.				
1887.795	21.7	272.2	1.03	1.03	8.5	9.5	V.	
7.798	21.5	269.7	1.00	1.00	8.5	9.5	V.	
8.551	20.7	267.9	0.92 a	0.92	8.5	9.5	III.	
1888.048		269.9		0.98	8.5	9.5		
β		268.0		0.87	8.3	9.1		
		β. 828, R. A. = 19h 41m.0		D. M., 5°, 4290 Dec. = + 5° 52′.				
1887.708	....	7.4	3.18	3.18	...	....	II.	
7.710	19.0	3.1	2.97	2.97	...	....	V.	
7.713	19.2	3.8	3.00	3.00	8.	10.	V.	
8.551	20.4	8.1	2.93 a	2.93	8.	10.	III.	
1887.920		5.6		3.02	8.0	10.0		Motion?
β		10.1		2.86	8.3	10.2		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 829, D. M., 5°, 4299

R. A.=19h 43m.0 Dec. = + 5° 27′.

1887.708	....	317.8	0.81	0.81	...	...	II.	Difficult.
7.710	19.8	313.5	0.91	0.91	..	...	V.	
7.713	19.6	311.4	1.08	1.08	8.5	10.	V.	
1887.710		314.2		0.93	8.5	10.0		Motion?
β		312.0		0.72	8.4	8.8		

W. O. 36, S. D., 20°, 5759

R. A. =19h 48m.2 Dec. = — 20° 39′.

1888.597	19.9	211.8	0.94 b	1.36	8.7	9.	III.	
8.605	20.3	218.9	1.24 a	1.24	9.	9.5	II.	
8.698	20.0	208.8	0.89 b	1.13	9.5	10.	V.	
1888.633		213.2		1.24	9.1	9.5		
β		214.3		1.02	8.5	9.0		

Σ. 2603,

R. A. =19h 48m.6 Dec. = + 69° 59′.

1888.802	2.3	362.5	2.80 a	2.80	4.	7.5	III.	
8.810	23.4	358.3	2.83 a	2.83	5.	8.	II.	
8.813	22.2	361.2	3.28 a	3.28	4.	8.	II.	
8.813	0.2	360.4	3.26 a	3.26	4.	8.	II.	
8.922	1.5	358.6	......	....	4.	8.	I.	Bad seeing.
8.936	6.2	366.6	2.98 a	2.98	4.5	7.5	V.	X inch.
9.006	3.4	361.4	......	....	5.	7.	V.	X inch.
9.060	5.8	366.2	2.67 a	2.67	4.	8.	V.	Bad seeing.
9.192	9.1	362.3	3.43 a	3.43	4.	8.	V.	Blazing.
9.219	9.6	365.3	3.06 a	3.06	4.	8.	V.	X inch.
9.586	20.8	360.3	3.04 a	3.04	4.	7.	V.	
1889.014		362.1		3.04	4.2	7.7		

β. 830, L1., 37916

R. A. = $19^h\ 49^m.0$ Dec. = $-1° 9'$.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				
1887.795	22.0	106.2	2.65	2.65	8.5	12.	V.	
7.798	21.7	103.3	2.97	2.97	8.	11.5	V.	
7.829	22.4	108.6	2.81	2.81	8.	12.	V.	
1887.807		106.0		2.81	8.2	11.8		
β		106.4		2.71	8.0	11.2		

W. O. 153, S. D., 13°, 5519

R. A. = $19^h\ 49^m.0$ Dec. = $-13° 24'$.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.701	20.9	113.7	2.05 a	2.05	9.5	10.5	II.	
8.731	20.9	113.9	1.68 b	2.14	9.5	10.	II.	
8.769	22.0	112.1	2.22 a	2.22	10.	11.	II.	
1888.734		113.2		2.14	9.7	10.5		

β. 831, D. M., 47°, 2955

R. A. = $19^h\ 52^m.0$ Dec. = $+ 47° 4'$.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.829	0.8	128.1	0.98	0.98	9.	9.5	V.	
7.887	23.5	133.9	0.80	0.80	9.	10.	V.	
8.548	18.3	124.8	0.92 a	0.92	8.5	9.	III.	
8.551	22.4	126.6	1.00 a	1.00	9.	10.	III.	
1888.204		128.3		0.92	8.9	9.6		
β		128.0		0.94	8.6	9.0		

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 154, S. D., 14°, 5634 (?)

R. A.= $19^h\ 58^m.9$ Dec.= — 14° 46′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.701	21.4	39.6	1.09 b	1.35	9.5	9.5	II.	
8.731	21.2	42.3	......	....	9.5	9.5	I.	
8.744	20.9	38.9	0.94 b	1.05	10.	10.	I.	
8.782	21.9	42.0	1.44 a	1.44	10.	10.	I.	
1888.753		40.7		1.28	9.8	9.8		

W. O. 155, W. B., xix, 1463

R. A = $19^h\ 59^m.7$ Dec. = — 13° 43′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.681	20.6	273.4	1.83 a	1.83	9.	10.	I.	
8.701	21.5	278.8	1.54 b	1.97	9.5	10.	II.	
8.769	22.3	274.8	1.33 b	1.69	9.5	10.5	II.	
1888.714		275.7		1.83	9.7	10.2		

W. O. 156, Lamont, 7278

R. A. = $20^h\ 0^m.0$ Dec. = + 1° 39′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.681	20.9	248.9	1.14 a	1.14	9.3	9.5	V.	
8.701	21.7	251.5	1.20 a	1.20	9.5	10.	II.	
8.760	21.2	249.2	1.12 a	1.12	10.	10.5	V.	
1888.714		249.9		1.15	9.6	10.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 832, Lamont, 3095

R. A. = 20h 0m.1 Dec. = —10° 59′.

1887.765	20.3	101.2	....	....	8.	9.5	III.	
7.795	22.2	101.6	1.45	1.45	8.8	9.5	V.	
7.798	22.0	104.7	1.24	1.24	9.	9.5	V.	
7.824	22.5	105.6	1.79	1.79	8.5	9.5	II.	
1887.795		103.3		1.49	8.6	9.5		
β		101.8		1.33	8.6	8.9		

W. O. 37, S. D., 4°, 5026

R. A. = 20h 2m.2 Dec. = —4° 1′.

1887.859	22.8	308.7	2.99	2.99	8.3	10.5	II.	
8.597	20.3	309.1	3.15 a	3.15	9.	12.	III.	
8.791	20.3	309.8	2.99 a	2.99	8.5	11.	I.	
1888.416		309.2		3.04	8.6	11.2		
β		313.6		3.04	8.6	11.4		

β. 833, Ll., 38625

R. A. = 20h 5m.2 Dec. = —6° 30′.

B. C.

1887.795	22.8	59.3	......	....	8.5	12.	V.	
7.798	22.2	63.3	2.26	2.26	8.5	12.	V.	
7.829	22.7	52.2	2.63	2.63	8.5	12.	V.	Very difficult.
8.893	22.1	61.9	2.47 a	2.47	8.5	12.5	I.	
1888.079		59.2		2.45	8.5	12.1		
β		63.7		2.29	8.8	11.7		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 157, Lamont, 477

R. A. = 20h 8m.6 Dec. = −24° 34′.

1888.681	21.1	235.0	1.77 b	2.29	9.	10.	V.	
8.717	22.0	235.2	2.42 a	2.42	9.5	10.	II.	
8.769	22.8	235.9	2.04 b	2.56	9.5	10.	II.	
1888.722		235.4		2.42	9.3	10.0		

Σ. 2675.

R. A. = 20h 12m.6 Dec. = + 77° 24′.

1888.810	23.0	124.8	7.44 a	7.44	4.	7.	III.	
8.813	0.5	124.6	7.15 a	7.15	4.	8.	II.	
8.922	1.8	125.4	7.04 a	7.04	5.	8.	I.	
8.971	3.1	128.5	7.33 a	7.33	4.	8.	V.	Seeing very bad.
9.025	2.9	129.2	7.28 a	7.28	5.	8.	V.	Seeing very bad.
9.060	5.6	125.1	7.32 a	7.32	4.	8.5	V.	
9.115	7.2	124.8	7.50 a	7.50	4.	8.	V.	
9.192	8.9	122.5	7.17 a	7.17	5.	8.5	V.	
9.219	9.2	122.4	7.63 a	7.63	4.	7.5	V.	X inch.
1889.014		125.3		7.32	4.3	7.9		

W. O. 158, Lamont, 7462

R. A. = 20h 15m.2 Dec. = + 2° 28′.

1888.681	21.3	17.1	1.28 a	1.28	9.5	10.	V.	
8.701	22.0	16.1	1.14 b	1.42	9.5	10.	II.	
8.760	21.4	15.8	1.11 a	1.11	9.5	10.	V.	
1888.714		16.3		1.27	9.5	10.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 38, Schj., 8070

R. A. = 20h 22m.8 Dec. = − 8° 25′.

1887.859	23.1	293.4	2.52	2.52	8.	10.	II.	
8.551	21.8	294.6	2.52 a	2.52	8.5	9.5	III.	
8.597	20.6	295.9	2.64 a	2.64	8.8	11.5	III.	
1888.336		294.6		2.56	8.4	10.3		
β		297.8		2.65	8.5	11.2		

W. O. 159. S. D., 12°, 5743

R. A. = 20h 23m.1 Dec. = − 12° 41′.

1888.698	20.6	284.0	1.06 b	1.31	10.8	11.	II.	
8.717	22.3	282.7	1.02 b	1.32	10.	10.5	V.	
8.769	22.5	282.0	0.92 b	1.12	10.7	11.	II.	
1888.728		282.9		1.25	10.5	10.8		

W. O. 160, W. B., XX, 612

R. A. = 20h 26m.2 Dec. = − 13° 57′.

1888.698	20.9	180.2	1.15 a	1.15	9.	9.	II.	
8.714	22.6	183.2	0.97 b	1.19	9.	9.	II.	
8.760	22.6	179.4	0.92 b	1.11	9.5	10.	II.	
1888.724		180.9		1.15	9 2	9.3		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 161, Ll., 39532

R. A. = 20h 26m.3 Dec. = — 9° 18′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.698	21.1	48.4	2.11 a	2.11	9.	11.	II.	
8.714	22.9	47.7	1.68 b	2.03	9.	11.	I.	
8.760	22.9	50.9	1.69 b	2.15	9.5	11.	II.	
1888.724		49.0		2.10	9.2	11.0		

W. O. 39, D. M., 50°, 3145

R. A.= 20h 33m.1 Dec. = + 50° 28′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.798	0.7	175.8	7.49	7.49	8.	10.	V.	
7.813	22.5	176.5	7.44	7.44	8.	11.	III.	
7.824	0.6	177.6	7.67	7.67	8.	9.5	II.	
1887.812		176.6		7.53	8.0	10.2		
β		176.3		7.60	8.0	10.8		

W. O. 40, O. Arg., 20773

R. A. = 20h 36m.6 Dec. = — 19° 55′.

A. B.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.859	23.4	357.7	5.37	5.37	8 8	9.	II.	
8.551	21.5	355.4	5.28 a	5.28	8.5	8.6	III.	
8.678	22.3	357.5	5.08 a	5.08	9.	9.5	I.	
1888.363		356.9		5.24	8.8	9.0		
β		357.9		5.30	8.6	8.9		

C. D.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.859	23.6	186.0	4.64	4.64	9.	10.	II.	
8.551	21.5	187.1	4.27 a	4.27	9.	9.5	III.	
8.706	20.4	186.5	4.54 a	4.54	9.	10.	II	
1888.372		186.5		4.48	9.0	9.8		
β		187.3		4.65	9.1	10.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
	h.	°	″	″				

W. O. 162, Schj., 8240

R. A. = 20h. 37m.6 Dec. = — 14° 8′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.698	21.3	139.5	1.77 a	1.77	10.	10.5	II.	
8.717	22.6	141.2	1.80 a	1.80	9.5	9.8	II.	
8.763	21.9	141.7	1.60 a	1.60	10.	10.	II.	
1888.726		140.8		1.72	9.8	10.1		

W. O. 163, L1., 40084

R. A. = 20h 38m.3 Dec. = — 9° 42′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.698	21.6	101.8	2.00 b	2.50	9.	11.	II.	
8.717	22.8	102.9	1.59 b	2.03	9.	12.5	II.	*Comes* 12m; 230° 10″ est.
8.760	23.1	107.9	2.05 b	2.56	9.5	12.	II.	
1888.725		104.2		2.36	9.2	11.8		

β. 834, D. M., 6°, 4638

R. A. = 20h 39m.8 Dec. = + 6° 43′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1887.795	23.1	131.6	2.31	2.31	8.	11.	V.	
7.798	22.5	130.4	2.04	2.04	8.5	10.5	V.	
7.829	22.9	137.9	2.07	2.07	8.5	11.5	V.	
1887.807		133.3		2.14	8.3	11.0		
β		134.0		2.43	8.5	11.0		

W. O. 164, W. B., XX, 988

R. A. = 20h 40m.0 Dec. = — 12° 44′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks
1888.698	20.8	115.8	2.56 b	3.10	9.	11.	II.	
8.717	23.2	113.5	2.67 a	2.67	9.	11.	II.	
8.760	23.4	114.8	2.19 b	2.72	9.	11.5	II.	
1888.725		114.7		2.83	9.0	11.2		

Date.	Sid. Time.	Observed.		Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
		p	s					
	h.	°	″	″				

W. O. 41, O. Arg., 21063

R. A. = 20^h $42^m.1$ Dec. = + 53° 35′.

A. B.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.813	23.0	233.8	....	....	8.5	12.	III.	
7.824	0.8	230.1	2.42	....	8.	11.5	II.	
7.832	22.9	236.8	3.39	3.39	8.5	12.	II.	
1887.823		233.6		3.39	8.3	11.8		
β		237.7		3.38	8.5	12.3		

A. C.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.798	0.9	258.4	7.92	7.92	8.	10.	V.	
7.813	22.8	262.4	7.92	7.92	8.5	10.5	III.	
7.824	0.7	259.4	7.92	7.92	8.	11.	II.	
1887.812		260.1		7.92	8.2	10.5		
β		262.8		7.85	8.4	11.0		

W. O. 42, S. D., 17″, 6113

R. A. = 20^h $46^m.5$ Dec. = − 17° 44′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.859	0.0	221.4	0.90	0.90	9.	9.	V.	
8.551	22.1	226.8	0.96 a	0.96	9.	9.	III.	
8.698	20.4	223.4	0.86 b	1.06	10.	10.	II.	
1888.369		223.9		0.97	9.3	9.3		
β		228.2		0.99	8.7	8.9		

W. O. 43, D. M., + 2°, 4262

R. A. = 20^h $46^m.8$ Dec. = + 2° 45′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	0.0	4.3	1.87 a	1.87	8.5	10.	II.	
7.859	0.2	7.1	1.53 b	1.99	8.5	12.	V.	
8.592	20.8	3.7	2.09 a	2.09	8.8	11.	III.	
1888.092		5.0		1.98	8.6	11.0		
β		3.7		1.90	8.4	10.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 165, O. Arg., 21032

R. A. = 20h 53m.8 Dec. = − 18° 7′.

1888.698	21.8	159.8	2.92 a	2.92	8.5	10.5	II.	
8.725	21.5	159.1	2.37 b	2.85	8.5	11.	I.	
8.763	22.2	164.9	3.27 a	3.27	9.	10.	II.	
1888.729		161.3		3.01	8.7	10.5		

β. 835, Ll. 40815

R. A. = 20h 58m.6 Dec. = + 7° 17′.

1887.710	20.3	251.8	1.07	1.07	...	...	V.	
7.713	20.2	251.8	1.17	1.17	8.5	10.	V.	
7.795	23.3	256.1	0.83	0.83	8.	10.5	V.	
1887.739		253.2		1.02	8.2	10.2		
β		255.7		0.84	8.0	11.0		

β. 836, D. M., 47°, 3291

R. A. = 21h 2m.4 Dec. = + 47° 54′.

A. B.

1887.829	1.0	191.4	0.53	0.53	9.	9.2	V.	
8.548	18.7	188.8	0.52 b	0.72	9.	9.	VI.	
8.884	23.0	188.6	0.69 a	0.69	9.5	9.	III.	X inch.
1888.087		189.6		0.65	9.2	9.1		
β		191.4		0.62	9.0	9.1		

AB, C.

1887.829	1.1	218.6	27.72	27.72	9.	10.	V.	
7.832	22.6	219.5	27.84	27.84	8.	9.5	II.	
8.788	23.1	218.6	26.83 a	26.83	8.	10.	V.	
1888.150		218.9		27.46	8.3	9.5		
β.		219.1		27.25	...	10.2		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 837, D. M.,—1°, 4170

R. A.=21h 2m.7 Dec.=—0° 16′.

1887.729	20.5	[179.9]	3.50	3.50	8.	9.5	V.	p. 10° wrong.
7.795	23.6	191.1	3.48	3.48	8.	10.5	V.	
7.798	22.8	187.5	3.61	3.61	8.	10.	V.	
1887.774		189.3		3.53	8.0	10.0		
β		189.7		3.68	8.4	10.1		

β. 838, Ll., 41462

R. A. =21h 14m.8 Dec. =+2° 37′.

1887.729	20.9	94.2	1.75	1.75	8.5	10.	V.	
7.795	0.0	93.7	1.47	1.47	8.	10.	V.	
7.798	23.0	99.5	1.92	1.92	8.	9.5	V.	
1887.774		95.8		1.71	8.2	9.8		Motion.
β.		90.3		1.28	7.6	9.5		

β. 839, D. M., 48°, 3348

R. A.=21h 16m.2. Dec.=+48° 50

A. C.

1887.829	1.6	197.8	21.34	21.34	8.	10.	V.	
7.832	0.3	198.0	21.51	21.51	8.	9.5	II.	
7.887	0.0	197.7	21.43	21.43	8.	10.	V.	
1887.849		197.8		21.43	8.0	9.8		
β.		197.0		21.36	8.5	9.4		

B. C.

1887.829	1.7	5.3	6.33	6.33	10.	11.	V.	The position angle should be increased 180°.
7.887	0.0	7.4	5.99	5.99	10.	12.	V.	
7.925	0.8	10.0	....	....	9.5	11.5	V.	
1887.880		7.6		6.16	9.8	11.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 44, O. Arg., 22177

R. A. = 21h 19m.4 Dec. = + 50° 1′.

1887.813	23.3	266.3	2.70	2.70	9.5	10.	V.	
7.824	1.1	268.6	2.27	2.27	8.	10.	II.	
8.695	23.6	268.7	2.60 a	2.60	8.	10.	II.	
1888.111		267.9		2.52	8.5	10.0		
β		272.3		2.70	8.4	10.4		

W. O. 166, O. Arg., 21387

R. A.=21h 19m.6 Dec.= −21° 56′.

1888.701	....	....	......	......	...	...	..	Not found.

Σ 2801.

R. A. = 21h 21m.7 Dec. = + 79° 58′.

1888.802	2.6	271.9	2.07 a	2.07	7.5	8.3	III.	
8.810	23.7	274.2	......	....	8.	9.	II.	
8.813	22.4	272.7	1.50 a	1.50	8.	9.	II.	
9.006	3.1	269.7	1.93 a	1.93	7.	8.	V.	X inch.
9.060	5.8	270.3	1.37 a	1.37	8.	9.	V.	
9.115	6.9	271.1	1.61 a	1.61	8.	8.5	V.	
9.192	8.3	271.7	1.70 a	1.70	8.5	9.5	V.	
9.219	8.9	272.0	1.55 a	1.55	8.	9.	V.	
9.586	20.3	273.0	1.70 a	1.70	8.	9.	V.	
1889.067		271.8		1.68	7.9	8.8		

W. O. 45, W. B., XXI, 591

R. A. = $21^h\ 25^m.4$ Dec. = + 34° 32′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.717	0.2	200.8	1.46 a	1.46	9.	9.5	II.	
8.769	23.9	200.6	1.05 b	1.29	9.2	9.8	II.	
8.782	23.5	198.1	1.50 a	1.50	9.	9.5	V.	
1888.756		199.8		1.42	9.1	9.6		
β		17.8		1.27	8.5	9.1		

W. O. 46, D. M., 35°, 4585

R. A. = $21^h\ 31^m.6$ Dec. = + 35° 52′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.717	0.6	199.6	2.01 a	2.01	9.5	9.5	II.	
8.769	0.2	199.0	0.97 b	1.20	9.8	10.	II.	
8.782	23.7	199.9	1.86 a	1.86	10.	10.	III.	
8.887	23.8	197.4	1.27 b	1.79	10.	10.2	III.	
1888.789		199.0		1.72	9.8	9.9		Motion in s.
β		200.4		1.17	9.5	9.8		

W. O. 47, D. M., 49°, 3578

R. A. = $21^h\ 34^m.2$ Dec. = + 49° 23′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.824	1.4	224.1	6.88	6.88	8.	11.5	II.	
8.788	23.6	220.6	6.51 a	6.51	8.	12.	I.	Difficult.
8.832	1.6	230.0	6.86 a	6.86	8.5	12.5	I.	Good obs.
1888.481		224.9		6.75	8.2	12.0		
β		228.9		6.60	8.4	12.0		

W. O. 167, S. D., 14°, 6111

R. A. = 21h 36m.9 Dec. = − 14° 43′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.698	22.3	287.2	1.86 a	1.86	10.5	11.	II.	
8.701	22.3	290.1	1.92 a	1.92	10.5	11.	II.	
8.763	22.7	288.0	1.80 a	1.80	10.3	10.5	II.	
1888.721		288.4		1.86	10.4	10.8		

W. O. 48, O. Arg., 22899

R. A. = 21h 44m.3 Dec. = + 51° 3′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	1.7	23.7	4.77	4.77	8.8	9.8	II.	
8.782	0.1	21.7	4.52 a	4.52	9.	10.	III.	
8.788	0.5	23.0	4.62 a	4.62	8.3	9.	I.	
1888.465		22.8		4.64	8.7	9.6		
β		22.9		4.42	8.6	8.9		

β. 840, Lamont, 8586

R. A. = 21h 46m.2. Dec. = − 2° 17′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	23.0	34.6	3.08	3.08	8.5	9.5	II.	
7.829	23.3	37.3	2.81	2.81	9.	10.	V.	
7.859	0.5	38.8	2.92	2.92	9.	10.	V.	
1887.837		36.9		2.94	8.8	9.8		Motion.
β		39.4		2.56	8.7	10.0		

W. O. 49, D. M., 28°, 4212

R. A. = 21h 46m.4 Dec. = + 28° 22′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.695	0.2	345.0	2.20 a	2.20	9.	10.5	II.	
8.717	0.9	340.8	2.31 a	2.31	9.	10.	II.	
8.769	0.4	337.8	1.82 b	2.29	9.	10.5	II.	
8.865	1.1	340.5	1.86 b	2.34	9.	11.	II.	
1888.762		341.0		2.28	9.0	10.5		
β		344.8		2.22	8.5	10.5		

W. O. 50, O. Arg., 22967

R. A. = 21h 47m.2 Dec. = + 53° 44′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	1.9	174.6	1.53	1.53	8.5	10.5	II.	
8.782	0.4	172.1	1.65 a	1.65	9.	10.	II.	
8.832	1.8	177.2	1.68 a	1.68	9.	10.5	III.	*Comes* 13.5 mag. $p=340°$ $s=5.″$
1888.479		174.6		1.62	8.8	10.3		
β		171.5		1.46	8.7	10.4		

β. 841, D. M., 53°, 2628

R. A. = 21h 49m.4 Dec. = + 53° 44′.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.829	1.9	191.7	2.06	2.06	8.5	12.	V.	
8.548	19.2	195.4	2.07 a	2.07	8.5	11.5	V.	
1888.188		193.6		2.06	8.5	11.8		
β		194.4		2.02	8.5	11.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
		W. O. 178,			Anon.			
		Near β, 841						
1887.887	0.4	172.7	1.72 b	2.23	9.	10.5	V.	Observed for β 841.
		W. O. 168,			Anon.			
		R. A. = 21h 54m.			Dec. = — 15° 20′.			
1888.698	22.5	342.3	2.57 b	3.11	11.	11.	II.	
8.701	22.6	339.9	3.23 b	....	11.	12.	II.	Very difficult.
8.763	22.9	339.0	2.33 b	2.86	11.	12.	II.	Difficult.
8.893	23.6	340.9	3.13 a	3.13	11.	11.5	I.	
1883.739		340.5		3.03	11.0	11.8		
		β. 842,			D. M. 4°, 4811			
		R. A. = 22h 3m.5			Dec. = + 5° 6′.			
1887.729	21.5	121.5	1.19	1.19	9.	10.	V.	
7.795	0.6	124.2	1.10	1.10	8.5	9.5	V.	
7.798	23.3	119.0	1.39	1.39	9.	9.5	V.	
1887.774		121.6		1.23	8.8	9.7		
β		121.1		1.25	8.8	9.1		
		β. 843,			D. M., + 1°, 4606			
		R. A. = 22h 18m.7			Dec. = + 2° 3′.			
1887.710	21.6	234.0	3.18	3.18	...	...	V.	
7.713	21.5	235.8	....	....	8.5	12.	V.	
7.729	21.9	233.2	3.01	3.01	8.5	11.	V.	
8.890	23.2	231.3	3.60 a	3.60	8.5	12.	III.	
1888.010		233.6		3.26	8.5	11.7		
β		236.1		3.44	8.4	12.5		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 844, L1., 43912

R. A. = 22h 23m.5 Dec. = + 5° 2′.

B. C.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.729	22.2	315.4	2.79	....	9.	11.5	V.	Probably a *b* measure.
7.795	1.0	314.8	....	....	9.	10.5	V.	
7.798	23.5	319.1	3.44	3.44	9.	10.5	V.	
7.829	23.6	316.6	3.45	3.45	9.	10.5	V.	
1887.788		316.5		3.44	9.0	10.7		
β		317.1		3.19	9.3	10.9		

W. O. 169, O. Arg., 22195

R. A. = 22h 24m.3 Dec. = — 19° 48′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.698	22.7	168.2	1.49 b	1.91	9.	10.	II.	
8.701	22.8	168.1	1.65 b	2.10	9.	10.	II.	
8.714	23.2	170.8	1.39 b	1.65	8.5	10.	I.	
1888.704		169.0		1.89	8.8	10.0		

W. O. 51, D. M., +1°, 4630

R. A. = 22h 29m.1 Dec. = + 2° 3′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.708	21.5	175.3	1.19	1.19	....	....	V.	
7.710	20.7	175.2	0.89	1.18	....	....	V.	
7.713	20.6	176.7	1.36	1.36	9.	9.3	V.	
1887.710		175.7		1.23	9.	9.3		Motion.
		181.1		0.90	8.5	8.9		

Σ. 2924.

R. A. = 22h 29m.9 Dec. = + 69° 22′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1888.791	1.7	270.8	0.85 a	0.85	7.2	7.5	III.	
8.884	23.8	269.2	0.87 a	0.87	7.	7.5	III.	
9.586	21.4	271.1	1.00 a	1.00	7.7	8.	V.	
9.636	22.1	267.8	0.75 a	0.75	7.5	8.	IV.	X inch.
90.096	8.3	269.0	0.75 a	0.75	6.5	7.	IV.	X inch.
1889.399		269.5		0.85	7.2	7.6		

W. O. 52, O. Arg., 24396

R. A. = 22h 32m.3 Dec. = + 50° 40′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	2.0	280.4	4.60	4.60	8.	10.5	II.	
8.782	0.6	284.9	4.54 a	4.54	8.5	10.	II.	
8.788	0.9	283.7	4.58 a	4.58	8.	11.5	II.	
1888.465		283.0		4.57	8.2	10.7		Motion.
β		289.3		4.73	8.1	11.1		

β. 845, O. Arg. 24526

R. A. = 22h 36m.4 Dec. = + 67° 53′.

A. B.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.765	20.7	198.9	......	....	8.5	12.	III.	
7.768	21.2	196.9	6.46	6.46	8.5	11.	III.	
7.829	2.1	195.8	5.99	5.99	8.5	12.	V.	
8.865	0.3	196.9	5.94 a	5.94	8.5	12.5	I.	
1888.057		197.1		6.13	8.5	11.9		Motion (?)
β		195.4		5.66	8.2	12.1		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 845, *Continued.*

A. C.

1887.765	20.7	14.2	15.42	15.42	8.5	11.5	III.	
7.768	21.3	9.6	15.74	15.74	8.5	11.0	III.	
7.829	2.2	11.4	14.99	14.99	8.5	12.5	V.	
1887.787		11.9		15.38	8.5	11.7		
β		9.1		15.43	8.2	13.2		

O. Σ. 481

R. A. = 22h 42m.0 Dec. = + 77° 54′.

1888.791	2.2	267.0	2.57 a	2.57	7.5	9.5	V.	
8.810	0.4	267.3	2.35 a	2.35	7.	9.	II.	
8.813	22.7	267.9	2.49 a	2.49	7.5	9.5	II.	
8.867	23.4	266.7	2.55 a	2.55	....	....	V.	X inch.
8.890	4.1	263.5	2.46 a	2.46	7.	8.5	III.	
8.922	2.8	266.9	2.91 a	2.91	8.	9.5	V.	
8.936	5.9	264.8	2.35 a	2.35	7.5	9.	V.	X inch.
9.006	3.6	266.4	2.32 a	2.32	7.	8.5	V.	X inch.
9.060	6.3	265.4	2.49 a	2.49	7.	9.	V.	X inch.
9.192	8.6	266.6	2.32 a	2.32	8.	9.	V.	
9.222	9.7	269.2	2.38 a	2.38	7.8	9.	V.	Bad seeing.
9.586	20.1	267.0	2.48 a	2.48	7.5	9.5	V.	
1889.008		266.6		2.47	7.4	9.1		

W. O. 53, Lamont, 4660

R. A. = 22h 42m.9 Dec. = — 7° 8′.

1887.708	22.2	359.2	1.75	1.75	...	....	V.	
7.710	21.1	356.6	1.65	1.65	...	....	V.	
7.713	21.1	358.3	1.79	1.79	9.5	10.5	V.	
1887.710		358.0		1.73	9.5	10.5		Motion (?)
β.		362.3		1.50	8.6	10.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

β. 846, Ll., 44688
R. A. = 22h 44m.6 Dec. = + 23° 54′.

1888.695	0.6	91.7	1.90 b	....	8.	12.5	II.	
8.890	23.4	92.8	1.84 a	1.84	8.5	12.	III.	
8.893	23.9	92.2	1.50 a	1.50	8.	12.5	II.	
1888.826		92.2		1.67	8.2	12.3		
β		93.4		1.72	8.6	12.2		

W.·O. 54, O. Arg., 24750
R. A. = 22h 45m.6 Dec. = + 50° 29′.

1887.824	2.2	192.1	1.95	1.95	9.	9.5	II.	
8.782	0.8	191.7	1.93 a	1.93	9.	9.5	II.	
8.788	1.1	193.6	1.80 a	1.80	9.	10.	II.	
1888.465		192.5		1.89	9.0	9.7		
β		195.9		1.75	8.7	8.9		

β. 847, W. B., XXII, 1103
R. A. = 22h 48m.8 Dec. = + 19° 42′.

1887.798	23.8	36.3	6.85	6.85	8.	9.	V.	
7.824	23.2	36.3	6.61	6.61	8.5	9.5	II.	
7.829	23.8	35.4	6.79	6.79	8.5	9.	V.	
1887.817		36.0		6.75	8.3	9.2		
β		37.4		6.36	8.5	9.2		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β. 848, D. M., 57°, 2629

R. A. = 22h 50m.0 Dec. = + 57° 44′.

1887.829	2.7	357.6	......	....	8.5	12.5	V.	
7.887	0.8	362.6	2.43	2.43	8.5	12.	V.	
8.944	3.4	361.8	......	....	8.5	13.	I.	
8 955	1.5	359.4	2.57 a	2.57	8.	12.5	I.	
9.977	1.8	358.1	......	....	..	....	I.	
90.085	2.8	362.6	2.06 a	2.06	8.	11.5	II.	
1888.946		360.4		2.35	8.3	12.3		Motion.
β		5.8		2.76	8.4	12.8		

β. 849, O. Arg., 24920

R. A. = 22h 51m.8 Dec. = + 66° 11′.

1887.829	2.4	128.2	4.46	4.46	8.5	11.5	V.	
7.887	1.0	126.4	4.01	4.01	8.5	12.	V.	
8.914	4.5	129.4	4.08 a	4.08	8.	12.	I.	
8.944	3.0	128.2	4.05 a	4.05	8.	12.	I.	
1888.394		128.0		4.15	8.2	11.9		Motion (?) in s.
β		127.0		3.72	8.4	12.3		

W. O. 55, W. B., XXII, 1210

R. A. = 22h 53m.9 Dec. = + 39° 38′.

1887.947	1.0	194.1	1.68 b	2.15	8.5	9.5	V.	
8.788	1.3	190.6	2.17 a	2.17	9.	10.	II.	
8.832	2.1	190.9	2.10 a	2.10	9.	10.	III.	
1888.522		191.9		2.14	8.8	9.8		Motion in s. (?)
β		191.7		1.81	9.1	10.1		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 56, D. M., 41°, 4656

R. A. = 22^h $54^m.2$ Dec. = + 41° 11′.

1887.947	1.4	124.8	0.91 b	1.15	8.5	9.	V.	
8.832	2.5	117.6	1.06 a	1.06	9.	9.	III.	
8.865	1.4	118.5	0.65 b	0.77	8.5	8.5	V.	
1888.548		120.3		0.99	8.7	8.8		
β		125.2		0.93	8.4	8.5		

β. 850, Ll., 44985.

R. A. = 22^h $54^m.4$ Dec. = + 13° 18′.

1887.829	0.0	118.8	3.20	3.20	8.	10.	V.	
7.859	0.9	121.2	3.33	3.33	8.	9.5	V.	
8.695	23.1	117.3	2.77 b	3.33	8.	10.5	II.	Bad seeing.
1888.028		119.1		3.29	8.0	10.0		
β		119.8		3.04	8.1	10.6		

β. 851, O. Arg., 25054

R. A. = 22^h $57^m.6$ Dec. = + 75° 29′.

1888.890	3.7	163.1	2.04 a	2.04	7.	13.	II.	
8.914	4.2	157.2	1.80 a	1.80	7.5	13.	I.	
8.955	2.4	160.9	2.12 b	2.57	7.5	13.	I.	
1888.920		160.4		2.14	7.3	13.0		Motion in s
β.		158.0		1.68	7.5	13.0		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 57, D. M., 50°, 3962

R. A. = 23h 3m.8 Dec. = + 50° 53′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.824	2.6	292.1	2.35	2.35	8.5	10.	II.	
7.947	1.6	289.6	2.22 a	2.22	8.5	9.5	V.	
8.788	1.6	292.0	2.47 a	2.47	8.8	10.	II.	
1888.186		291.0		2.35	8.6	9.8		
β		295.8		2.45	8.7	10.3		

O. Σ. 489

R. A. = 23h 4m.5 Dec. = + 74° 49′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.884	23.6	26.2	1.07 a	1.07	5.	7.	III.	
89.586	21.8	33.9	1.11 a	1.11	...	...	III.	Definition poor.
89.636	21.8	31.6	1.07 a	1.07	...	8.	IV.	X inch.
90.071	2.5	28.0	1.12 a	1.12	...	8.	IV.	Good observation.
90.085	2.3	30.0	1.01 a	1.01	4.	7.5	X.	Definition poor.
90.096	2.7	30.2	0.91 a	0.91	...	...	IV.	X inch.
1889.726		30.0		1.05	4.5	7.6		

β. 852, Pegasi, 306

R. A. = 23h 4m.8 Dec. = + 25° 52′.

A. B.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.760	20.4	283.4	58.36	58.36	7.	10.5	II.	
7.781	21.2	283.0	58.97	58.97	....	....	II.	
7.859	1.2	282.8	58.54	58.54	....	....	V.	
1887.800		283.1		58.62	7.0	10.5		
β		282.6		58.27	7.0	10.8		

β. 852, *Continued.*

B. C.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				
1887.852	1.1	9.0	1.70	1.70	9.5	10.	V.	
8.890	23.6	9.3	1.58 a	1.58	10.5	11.	III.	
8.893	0.1	11.4	1.20 b	1.71	11.	11.5	III.	Difficult.
1888.212		9.9		1.66	10.3	10.8		
β		11.2		1.19	10.8	11.3		

W. O. 170, S. D., 22°, 6088

R. A. = 23^h $6^m.4$ Dec. = −22° 35′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.701	23.1	278.2	1.26 b	1.59	10.	11.	II.	
8.717	23.8	277.7	1.19 b	1.50	9.	10.	II.	
8.763	23.2	277.3	1.05 b	1.29	9.	10.	II.	
1888.727		277.7		1.46	9.3	10.3		

W. O. 171, W. B., XXIII, 195

R. A. = 23^h $11^m.5$ Dec. = + 16° 12′.

Date.	Sid. Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1888.695	1.4	33.1	2.63 a	2.63	9.	10.	II.	
8.701	23.3	31.1	2.41 a	2.41	9.	10.	II.	
8.760	23.8	30.9	2.55 a	2.55	9.	10.	II.	
1888.719		31.7		2.53	9.0	10.0		

β. 853, O. Arg., 25370

R. A. = 23h 11m.6 Dec. = + 61° 9′.

A. B.

Date.	Sid Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.768	22.2	220.5	......	....	..	...	III.	
7.781	21.6	222.8	......	....	..	...	II.	
8.548	20.0	223.7	0.6 est	0.60	..	..	III.	X inch.
8.884	0.4	227.3	0.57 a	0.57	8.	8.3	IV.	X inch.
8.890	2.0	228.2	0.33 b	0.49	8.5	8.8		
1888.374		224.5		0.55	8.2	8.6		
β		228.8		0.62	8.7	8.7		

AB, C.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.768	22.1	71.2	......	...	8.5	13.	III.	
7.781	21.8	65.4	6.36	6.36	...	13.	II.	
7.925	1.4	70.4	......	....	8.5	12.	III.	
8.548	20.2	72.3	7.11 a	7.11	9.	12.	III.	
1888.005		69.8		6.74	8.7	12.5		
β		67.3		7.31	...	13.0		

β. 854, D. M., 5°, 5164

R. A. = 23h 13m.2 Dec. = +5° 23′.

Date.	Sid Time.	p	s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
1887.683	22.1	88.9	2.27	2.27	...	...	V.	
7.710	21.9	85.9	2.43	2.43	8.8	9.0	V.	
7.713	21.0	88.9	2.43	2.43	8.	8.3	I.	
1887.702		87.9		2.38	8.4	8.6		
β.		90.0		2.09	8.7	8.7		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

W. O. 58, O. Arg., 25809

R. A. = $23^h\ 30^m.9$ Dec. = + 53° 17′.

1887.824	2.7	353.8	3.12	3.12	8.5	10.5	II.	
7.947	1.9	358.5	3.36 a	3.36	8.5	11.	V.	
8.788	1.8	355.3	3.64 a	3.64	8.5	12.	II.	Motion.
1888.186		355.9		3.37	8.5	11.2		
β		361.0		3.68	8.6	10.8		

β 855, D. M., 67°, 1546

R. A. = $23^h\ 32^m.3$ Dec. = + 67° 33′.

				0.75	9.	10.	V.	
1887.760	22.7	196.6	0.75	0.90	8.5	9.5	III.	X inch.
8.884	0.8	198.0	0.65 b	0.72	8.	8.5	IV.	X inch.
8.890	2.2	202.6	0.72 a	0.79	8.5	9.3		
1888.511		199.1		0.82	8.5	8.8		
β		204.2						

β 856, O. Arg., 25859

R. A. = $23^h\ 33^m.0$ Dec. = + 69° 58′.

1888.884	1.1	269.2	0.37 b	0.62	8.	10.	IV.	X inch.
8.890	2.4	266.9	0.39 b	0.65	8.	9.	IV.	X inch.
8.914	4.8	267.4	0.41 b	0.71	8.5	9.5	IV.	
1888.896		267.8		0.66	8.2	9.5		
β		266.0		0.58	8.1	9.1		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
		W. O. 179, R. A. = 23h 33m.3		D. M., 43°, 4518 Dec. = + 43° 15′.				
1887.664	....	132.9	3.74	3.74	9.	11.	I.	
7.683	22.1	130.0	3.85	3.85	...	...	I.	
7.925	1.8	134.3	3.94	3.94	8.5	10.5	III.	
1887.757		132.4		3.84	8.8	10.8		
		β 857, R. A. = 23h 35m.0		D. M., 66°, 1630 Dec. = + 66° 53′.				
1887.760	22.1	296.4	1.49	1.49	8.	9.	III.	
7.768	22.5	298.2	1.78	1.78	8.8	9.5	III.	
7.790	22.5	295.2	1.72	1.72	8.5	9.5	VI.	
1887.773		296.6		1.66	8.4	9.3		
β		296.9		1.38	8.5	8.9		
		β 858, R. A. = 23h 35m.3		Ll, 46423 Dec. = + 31° 54′.				
				A. B.				
1887.713	22.6	271.2	0.76	0.76	8.5	8.8	V.	
7.757	21.1	274.2	0.67	0.67	8.8	9.5	III.	
7.760	20.8	271.9	0.69	0.69	8.0	9.0	III.	
1887.743		272.4		0.71	8.4	9.1		Motion (?).
β		276.6		0.48	7.7	8.2		
				AB., C.				
1887.729	23.0	50.3	24.22	24.22	...	...	V.	
8.895	0.8	54.5	23.89 a	23.89	7.5	12.	II.	Seeing poor.
1888.312		52.4		24.06	7.5	12.0		
β		51.0		23.55	...	12.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	"	"				

β 859 W. B., XXIII, 961

R. A. = 23h 46m.6 Dec. = + 22° 18′.

1887.757	21.7	216.6	0.62	0.62	9.	9.	III.	
7.829	0.4	210.3	0.71	0.71	9.	9.	V.	
7.859	1.5	217.5	0.60	0.60	9.	9.	V.	
1887.815		214.8		0.64	9.0	9.0		
β		217.3		0.63	8.5	8.5		

β 860, Andromedæ, 6

R. A. = 23h 53m.9 Dec. = + 38° 11′.

1887.757	22.1	105.0	7.03	7.03	6.	12.	III.	
7.760	21.2	106.8	6.26	....	7.	11.5	III.	Probably b.
8.788	2.4	108.6	6.78 a	6.78	..	12.	I.	
9.586	19.3	105.0	6.73 a	6.73	6.	12.	I.	X inch.
1888.473		106.4		6.85	6.3	11.9		
β		107.2		6.67	6.8	11.6		

W. O. 59, O. Arg., 26248

R. A. = 23h 54m.0. Dec. = + 52° 35′.

A. B.

1887.824	2.9	8.3	1.42	1.42	9.	9.	II.	
8.890	3.4	11.8	1.15 a	1.15	8.	8.2	III.	
8.931	1.4	13.4	1.07 a	1.07	8.	8.2	III.	Seeing poor.
8.971	2.1	10.6	1.10 a	1.10	9.	9.	V.	
9.060	3.6	11.9	0.98 a	0.98	8.5	8.5	III.	
1888.735		11.2		1.14	8.5	8.6		
β.		12.3		1.02	8.6	8.8		

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				

W. O. 59, *Continued.*

A. C.

1887.824	3.0	305.4	19.42	19.42	9.	9.	II.	½ (A + B), C.
9.006	2.5	309.4	19.41	19.41	8.5	10.	V.	
1888.414		307.4		19.42	8.8	9.5		
β		307.5		19.74	8.6	10.8		

W. O. 60, D. M., 38°, 5112

R. A. = 23h 55m.3 Dec. = +38° 58′.

1887.757	23.9	107.5	0.61	0.61	8.	9.	III.	
8.890	3.2	102.4	0.31 b	0.47	8.	8.5	IV.	
1888.174		105.0		0.54	8.0	8.8		Motion.
β		124.1		0.62	8.5	8.9		

β 861, D. M., 68°, 1422

R. A. = 23h 56m.9 Dec. = + 69° 2′.

1887.691	21.9	176.7	1.87	1.87	9.5	10.	II.	
7.760	21.6	179.5	1.68	1.68	9.	9.	III.	
7.947	2.7	177.2	....	....	9.5	9.5	V.	
1887.799		177.8		1.78	9.3	9.5		Motion in s.
β		177.4		1.29	9.4	9.7		

β 862, W. B., XXIII, 1245

R. A. = 23h 58m.6 Dec. = + 37° 30′.

1887.757	22.4	107.1	0.56	0.56	8.5	9.	III.	
8.890	2.6	107.9	0.33 b	0.54	8.5	9.	IV.	X inch.
1888.324		107.5		0.55	8.5	9.0		
β		104.9		0.54	8.5	8.8		

β 863. D. M., 72°, 1139

R. A. = 23^h $59^m.7$ Dec. = + 72° 55′.

Date.	Sid. Time.	Observed. p	Observed. s	Corrected Distance.	Magnitudes.		Eye-piece.	Remarks.
	h.	°	″	″				
1887.691	22.8	119.9	1.83	1.83	....	....	II.	Clouds.
7.760	21.9	121.2	2.27	2.27	8.5	9.5	III.	
8.701	23.9	124.3	1.43 b	1.81	9.	11.	II.	
8.848	23.7	120.9	2.03 a	2.03	9.	10.	V.	
1888.025		121.6		1.98	8.8	10.2		
β		123.7		1.59	9.2	11.0		

ADDENDUM.

The following observation of Cancri was made after page 72 of this volume had been printed. It should be combined with the observation contained on that page.

ζ Cancri

R. A. = 8^h $5^m.3$ Dec. = + 18° 0′.

A. B.

1890.288	11.8	35.8	0.91 a	0.91	....	....	VIII.

B. C.

1890.288	12.0	128.0	5.54 a	5.54	....	....	VIII.

PUBLICATIONS

OF THE

WASHBURN OBSERVATORY.

VOL. VI.

PARTS 3 AND 4.

MADISON, WIS.:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS,
1892.

PUBLICATIONS

OF THE

WASHBURN OBSERVATORY.

VOL. VI. PART 3.

OBSERVATIONS OF TELESCOPIC VARIABLE STARS OF LONG PERIOD.

BY

SIDNEY DEAN TOWNLEY.

MADISON, WIS.:
DEMOCRAT PRINTING COMPANY, STATE PRINTERS,
1892.

The Washburn Observatory.

FOUNDED BY

Cadwallader C. Washburn,

Born 1818; Died 1882.

INTRODUCTION.

The following observations of variable stars of long period were made with the Clark equatorial telescope, aperture 39.5 cm., described in Vol. I of the Publications of this observatory. The zone eyepiece, which gives a field of 25.′5 and a magnifying power of 145 diameters, was used in all the observations. Both the large telescope and the finder were used in the observation of stars brighter than the tenth magnitude.

The finder has an aperture of 8.9 cm., a field of 2° 7′ and a magnifying power of 20 diameters.

METHOD OF OBSERVING.—Before commencing these observations of variable stars I was unfamiliar with the methods of observing, and I was led to adopt the method I have followed from suggestions contained in a pamphlet, "*A Plan for Securing Observations of the Variable Stars*," by Professor E. C. Pickering. The following extract is taken from page 10: "Herchel and Argelander have independently invented what appears to be the true method to be followed. . . . . Let v represent a star which is suspected to be variable, and a an adjacent star of nearly equal brightness. If the stars appear equal after a careful examination, or if one appears brighter as often as it appears fainter than the other, we may denote the equality by a v or v a, these terms having precisely the same meaning. If one of the stars is suspected to be brighter,—that is, if it appears sometimes brighter and sometimes fainter, but more frequently brighter, the interval may be designated as one grade. The observation may be written a 1 v or v 1 a, the brightest star being named first. If one star is certainly brighter than the other, the difference, however, being very small, so that they sometimes appear equal, the difference will be two grades, and may be written a 2 v or v 2 a. Greater intervals may be estimated as three or four grades, but such observations have much less value. It is found in practice that a grade thus estimated will slightly exceed a tenth of a magnitude. . . . The principal objection to this method is the difficulty of determining the value of a grade, as it is liable to vary with the observer, the time, the condition of the air, and the brightness of the stars. These difficulties are avoided by the following method. Select two stars for comparison; one a, slightly brighter than the star to be measured, v, the other, b, slightly fainter. The interval between a and b should never exceed one magnitude. Estimate the brightness of v in tenths of the interval from a to b. Thus, if v is midway between a and

b the interval will be five-tenths, and we may write $a\ 5\ b$. If v is nearly as bright as a, we may have $a\ 1\ b$ or $a\ 2\ b$; if v is not much brighter than b, we may have $a\ 8\ b$ or $a\ 9\ b$. *An advantage of this method is that larger intervals in brightness may be used between the comparison stars, and accordingly less distant stars employed.*" (Italics mine.) "An increase in distance of the stars always renders the comparison more difficult. We can also obtain many independent comparisons by using several comparison stars. If we have m stars brighter and n fainter, we shall only have $m + n$ independent measures by the method of grades, while we may have $m\ n$ comparisons by estimating tenths, since estimates may be made in terms of the intervals between each brighter and each fainter star. On the other hand, especially when observing stars not very near together, it is a decided advantage to have to compare two stars rather than three. Each method has its advantages, and that to be used should doubtless depend on the temperament of the observer."

Upon reading the above quotation it seemed to me that the second method was the better of the two, and I have consequently used it almost entirely, although Professor Pickering, in a private letter, has since advised the use of the Argelander method. I have used the Argelander method to some extent, and there seems to be but little choice between them. As stated, in the quotation above, each method has its advantages, and I am of the opinion that the best results can be obtained by the use of both methods, the one to be used in any particular case depending upon the distances and the differences of brightness in the comparison stars available.

COMPARISON STARS. — I have determined, by eye estimation, the magnitude of each of the comparison stars used. These estimates are based upon the assumption that the *minimum visibile* of the finder is 10.3^m, and of the large telescope 14.7^m. Professor Holden assumed the *minimum visibile* of the large telescope to be 15.1^m, in the Argelander system extended, but several electric lights have since been erected in the neighborhood of the observatory, and their effect is appreciable, although perhaps not so great as I have here supposed. When I began observing, I found that there were a few stars visible with the finder which were not on the Durchmusterung charts, and in order to make my scale join that of the Durchmusterung I thought it safe to assume the *minimum visibile* of the finder a little greater (numerically) than the faintest stars given on the Durchmusterung charts and therefore adopted 10.3^m.

In estimating magnitudes it has been my custom to start with a star near the limit of visibility in the finder, and to estimate the next brighter star and so on down the numerical scale; then to come back to the starting point and estimate up the numerical scale to stars of about 12.5 magnitude. Stars fainter than 12.5^m were estimated from the *minimum visibile* of the large telescope. A deficiency of stars between 13^m and 14^m seems to indicate that the difference between the *minimum visibile* of the finder and that of the large

telescope is too great, and I find, according to Pogson's light ratio and the assumption made by Professor Young, General Astronomer, page 469, that the *mimimum visibile* of the larger telescope should be 15.0m, and that of the finder 11.8m. Assuming the *minimum visibile* of the large telescope to be 14.7m, then that of the finder should be 11.5m, which is 1.2m greater than I assumed.

From twenty-four Durchmusterung stars, between 8m and 9m, of which I have estimated the brightness, I find the following difference:

$$\text{B. D.} - \text{T.} = +\overset{\text{m}}{0.15} \pm \overset{\text{m}}{0.04},$$

and from twenty-seven Durchmusterung stars, between 9m and 10m,

$$\text{B. D.} - \text{T.} = \overset{\text{m}}{0.00} \pm \overset{\text{m}}{0.03},$$

so that the assumption that the *minimum visibile* of the finder is 10.3m, although from theoretical considerations quite erroneous, makes my scale join closely to that of the Durchmusterung.

I have also made a comparison of my system with the standards of stellar magnitudes given in the "Proceedings of the American Association for the Advancement of Science," vol. xxxiv., page 23. There are twenty-four sets of stars, the magnitudes of most of which were determined with the Harvard Photometer. I have observed four of these sets and the following table will show the relation of my system of magnitudes to that of the Standard.

The stars named at the head of the columns are the identification stars given in the "Proceedings."

In the first column are letters designating the stars of which the magnitudes have been determined. In the column under Mag. are given the standard determinations and my own and in the fourth column are the differences. St.—T

Each of my magnitudes is the mean of five independent estimates. The general mean is, St.— T. = + 1.58m. The symbol ( ) indicates that the star was invisible, on each of the five nights.

	ε Hydrae. I.			α Leonis. II.			ϑ Leonis. III.			η Virginis. IV.		
	Mag.			*Mag.*			*Mag.*			*Mag.*		
Des.	St.	T.	St.-T.	St.	T.	St.-T.	St.	T.	St.-T.	St.	T.	St.-T.
a	9.6	8.6	+1.0	8.7	8.1	+0.6	9.7	9.0	+0.7	11.3	9.2	+2.1
b	10.1	8.8	1.3	12.0	9.6	2.4	10.8	9.6	1 2	11.5	9.3	2.2
c	11.3	9.4	1.9	12.7	10.2	2.5	11.6	10.0	1.6	11.8	9.8	2.0
d	11.8	9.9	1.9	13.2	10.8	2.4	12.8	11.5	1.3	12.6	10.4	2.2
e	13.0	11.2	1.8	13.2	11.1	2.1	12.8	11.5	1.3	12.8	10.6	2.2
f	13.0	10.5	2.5	13.6	11.6	2.0	13.6	12.1	1.5	13.0	10.9	2.1
g	13.9	.....	......	14.6	( )	......	13.8	12.4	1.4	13.9	12.0	1.9
h	14.2	12.9	1.3	14.8	( )	......	14.2	13.3	0.9	14.2	12.8	1.4
i	14.4	13.1	1 3	15.0	( )	.....	15.0	13.7	1.3	14.5	14.0	0.5
j	15.0	14.6	0.4	15.6	( )	... ..	15.6	14.6	1.0	14.9	14.6	0.3
k	15.1	( )	......	15.6	( )	....	15.6	( )		15.5	14.7	0.8
l										15.5	( )	
Mean.			1.49			2.00			1.22			1.61

Collecting these differences according to magnitudes we have the following table, in which the third column gives the values of St.—T. graphically adjusted.

Mag. T.	St.—T.	Adj. St.—T.
8—9	+0.97	+1.0
9—10	1.80	1.7
10—11	2.21	2.0
11—12	1.70	1.9
12—13	1.54	1.6
13—14	1.20	1.1
14—14.7	0.60	0.6

These observations seem to indicate systematic differences among the several sets of standards. In set III, I have observed a 15.6 m star and in set IV a 15.5 m, while in set II it was impossible to see a 14 6 m star. In set II also, the star c, 12.7 m was seen in the finder upon four out of five nights.

My adopted magnitudes of the comparison stars are each the means of five separate estimates upon different nights. No estimates were made except when the seeing was "good" or "excellent," the moon invisible and the stars at a considerable distance from the horizon. The probable error of a single estimate of the magnitude of a comparison star is shown by the following table. In the column headed *n* are the number of estimates, and in the column headed μ the number of stars estimated.

Mag.	*n.*	μ	*p. e.*
7-8	29	6	m ±0.19
8-9	111	23	0.17
9-10	141	29	0.17
10-11	185	38	0.11
11-12	150	31	0.17
12-13	94	19	0.19
13-14	48	9	0.20
14-14.7	54	11	0.15
Mean....	....	....	±0.17

EXPLANATION OF TABLES.—The number and name of the star, its right ascension and declination for 1855.0, are taken from Chandler's Catalogue of Variable Stars published in numbers 179 and 180, of the *Astronomical Journal.* The first column contains the date of observation: the second column, the nearest hour, mean solar time of the ninetieth meridian west of Greenwich; the third column the magnitude of the variable resulting from the observations, reduced by my system of magnitudes; the fourth column the observed data from which the magnitudes were derived.

Wherever the letter v occurs it stands for variable. There are two systems of notation used. The expression va means that the brightness of the variable was the same as that of the comparison star a. The form v 3 a means that the variable was three grades brighter than a; v 2 — 3 a, that the variable was two or three grades brighter than a; v — a, that v was an uncertain amount brighter than a. The expression a 3 b is equivalent to v = a + 0.3 (a — b), so that the numerals used have sometimes one meaning and sometimes another.

In one case the numeral denotes a number of grades and in the other case, tenths of a difference of the brightness between two stars. In each of these notations the brighter star is always written first. The value of a grade was obtained in the following way.

Many times when I have estimated the brightness of the variable between two comparison stars I have estimated also the number of grades that the variable was brighter or fainter than the nearer (in brightness) of the two comparison stars, and this, taking the adopted magnitudes of the comparison stars, gives the value of one grade. Suppose an observation to be, — a 7 b, v 3 b. If a — b = 0.9m, then the value of a grade, in this particular case, is 0.09m. The mean value of one grade, from 163 such observations was found to be 0.092m, but in the reduction of the observations I have assumed that one grade equals 0.10m. The expression (v), means that the variable was invisible. A : after an observation means that it is not very reliable, and :: that the observation is more of a guess than an estimate. The estimated magnitudes sometimes given in the column "observation," are often only very rough estimates and little or no weight has been given to them. The abbreviation est. is used for estimated; vis. for visible, alt. for altitude, ft. for faint and br. for brighter. Where nothing is said with regard to the seeing it was either "good" or "fair". "Good" seeing means that the images of the stars were steady and well defined; "fair", that the images were a little unsteady or a little diffuse; "poor", that the images were very unsteady or very diffuse or both. Low means that the star was near the horizon. No allowance has been made for atmospheric absorption, either in the reductions or in the estimation of the comparison stars.

The comparison stars in the table are designated by the letters of the alphabet, beginning with the brightest as a. The second column contains the Durchmusterung designation of the star; columns three and four, the magnitudes of the comparison stars, those under B. D. being Durchmusterung magnitudes and those under T. being my estimated magnitudes. Most of these magnitudes are the means of five separate determinations, but those printed in italics are the mean of four estimates. The fifth column contains the co ordinates of the comparison stars, being the corrections that must be applied to the co ordinates of the variable to give those of the comparison star. The co-ordinates of all stars given in the Durchmusterung were taken from that catalogue. The co ordinates of variables not given in the Durchmusterung were taken from Chandler's catalogue, and the co-ordinates of all other stars were determined by myself from transits of the stars over a mica scale, graduated to minutes of arc. fixed in one edge of the eyepiece. Each of these co-ordinates is the mean of four determinations, two on one night and two on another.

In the column of remarks are given the observed times of maximum and minimum, taken from the plotted curves, and the resulting intervals. O—C is

the observed time minus the computed time, from the elements given in Chandler's catalogue. The observed times of maxima were compared also with the elements given in Gore's Revised Catalogue of Variable Stars, (Proceedings of the Royal Irish Academy, 3rd Series, Vol. I, No. 1), but in nearly every case the observed data were represented better by Chandler's elements than by Gore's and hence only the comparison with the former is published. E gives the number of periods that have elapsed since the epoch given in Chandler's catalogue. C. P. stands for Chandler's Period.

I wish here to express my thanks to Professor Asaph Hall, of the United States Naval Observatory, and to Professor Ormond Stone, Director of the Leander McCormick Observatory, for two very valuable observations kindly made by them upon the stars R Piscium and X Capricorni.

MADISON, June, 1892.

112. R ANDROMEDÆ.

R. A. = 0^h 16^m 25^s. Decl. = + 37° $46'.4$.

Date.			Hour.	Mag.	Observation.
1889.	Dec.	6.	9	9.0	v d.
		14.	10	9.2	d 5 v:, v 5 e:.
		22.	11	9.5	v e.
1890.	Jan	8.	9	9.7	e 3 f.
	Feb.	8.	9	10.8	g 2 l, v h.
		14.	9	11.0	v l. Low.
		15.	9	11.0	h 2 m, l o—1 v.
	Mar.	8.	7	11.7	h 8 m.
		15.	7	11.7	h 8 m:. Seeing poor.
	July	15.	15	9.0	v d, v 5 e, v est. 8.
		23.	13	8.6	b 7 d.
	Aug.	5.	11	8.2	b 4 d.
	Sept.	9.	9	6.2	v a.
		22.	10	6.2	v o—1 a.
	Oct.	17.	8	6.6	a 2 c, a 4—5 v.
	Nov.	10.	8	7.3	a 6 c, v 5 b.
		18.	8	7.8	a 8 c, b 2 v.
		23.	12	8.0	v o—1 c, b 2 v.
		27.	11	8.3	c 1 — 2 v.
	Dec.	6.	13	8.2	b 4 d.
		10.	12	8.3	b 5 d.
		14.	12	8.6	b 7 d.
		23.	9	8.6	b 7 d.
1891.	Jan.	2.	8	8 7	b 8 d.
		11.	8	8.8	v 2 d, v 6 e.
		24.	7	9.2	d 3 e, v 4 e.
	Feb.	2.	7	9.4	v 1 e.
		10.	7	9.8	e 8 v.

Date.			Hour.	Mag.	Observation.
1891.	Feb.	21.	7	10.1	f 1 g.
		26.	7	10.3	f 4 g, v vis. in finder.
	Mar.	9.	7	10.5	f 7 g, v 3 g, v very ft. in finder.
		13.	7	10.7	v o—1 g.
	Sept.	12.	10	11.5	h 7 m, 15 v.
		15.	9	11.3	h 5 m, 12 v.
		19.	9	10.9	h 2 m, v l.
		22.	7	10.9	h 2 m, v l.
		29.	9	10.2	e 7 h, v 8 l, v ft. in finder.
	Oct.	4.	10	9.5	v e.
		9.	9	9.1	v 3—4 e.
		15.	9	8.6	v 5 d, v 7 e.
		19.	8	8.4	b 6 d, v 7 d.
		22.	8	8.4	b 6 d.
		25.	9	8.3	b 5 d.
		27.	9	8.3	b 5—6 d.
	Nov.	1.	7	8.2	b 4 d.
		5.	12	8.0	b 3 d.
		8.	7	8.0	b 3 d, b 4 v.
		10.	12	7.8	b 2 v, v orange.
		17.	9	7.8	b 2 v.
		28.	11	7.7	b 1 v.
		30.	10	7.6	v b.
	Dec.	4.	12	7.7	b 1 d, b 2 v.
		6.	11	7.7	b 1 v.
		10.	11	7.8	b 2 v, v yellow with tinge of red.
		15.	11	7.8	b 1—2 d, b 2—3 v.
		23.	10	7.9	b 2 d, b 3 v.
		26.	11	8.1	v e, b 4 v.
1892.	Jan.	6.	10	8.0	b 3 d, b 4 v.
		9.	8	8.2	b 4 d.
		14.	10	8.2	b 4 d.

Date.		Hour.	Mag.	Observation.
1892.	Jan. 20.	10	8.3	b 5 d, v 10 e.
	21.	10	8.3	b 5 d.
	24.	9	8.3	b 5 d.
	26.	9	8.4	b 6 d.
	Feb. 5.	8	8.5	b 6—7 d, c 6 d, v 6—7 d.
	11.	7	8.6	b 7 d, c 6 d.
	25.	9	8.6	b 7 d, v 5 d.
	Mar. 1.	8	8.6	b 7 d, v 8 e, v 4—5 d.
	8.	7	8.8	v 2 d, v 7 e.
	23.	7	9.0	v d, v 5 e.
	28.	7	9.3	d 7 e, v 2—3 e.
	May 20.	14	11.2	h 3 m, l 4 v.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	+37°, 45	5.7	6.2	—174	—36.7	M, 1890, Sep. 16. O — C = +6.7d, E = 7.
b	54	7.0	7.6	— 64	+10.7	M, 1891, Dec. 1. O — C = +36.5, E = 8.
c	48	7.5	*8.2*	—147	—23.1	Interval 441d. C. P., 411.2d. See A. J.
d	59	9.2	*9.0*	+ 25	—13.4	No. 251. The observations indicate
e	57	9.2	*9.5*	— 31	+ 0.3	that the difference between the compar-
f	....	....	*10.0*	+ 21	—11.0	ison stars b and d is too small by about
g	....	....	*10.7*	— 0	— 3.2	0.3m.
h	....	...	*10.7*	— 30	+ 1.1	
l	....	....	*11.0*	+ 4	— 1.1	
m	....	....	*11.9*	— 27	+ 1.5	

114. S Ceti.

R. A. = $0^h\ 16^m\ 41^s$ Decl. = — $10°\ 7'.9$

Date.			Hour.	Mag.	Observation.
1889.	Dec.	6.	9	10.6	v h, g 2 v.
		12.	8	10.6	f 8 v, g 1 v.
		14.	9	10.7	v h.
		22.	9	10.9	h 2 v.
1890.	Jan.	7.	8	12.1	l 2 v: Moon.
		8.	8	12.4	l 5 m. Moon.
	Feb.	8.	7	13.3	l 8 v. Very difficult, Alt. 25°.
		14.	8	<13	(v). Alt. 12°.
	July	15.	15	8.1	a 5 b. Seeing poor.
		23.	13	9.4	b 5 g, b 10 v, v est. 9.
	Aug.	19.	14	8.6	b 4 d, b 1 g.
	Sept.	10.	14	8.7	b 7 c, v 3 d, v 7 c ?
		22.	10	9.4	d 5 e, c 3 v, v est. 9.0.
	Oct.	14.	9	9.9	f 5 e, v very ft. in finder.
	Nov.	4.	10	10.4	c 8 h:
		10.	9	11.7	v k.
		11.	9	11.3	g 7 k, v 4 k, v est. 11.5.
		18.	11	11.8	k 5 l. Seeing poor.
		27.	9	12.1	l 3 v. Bright moon.
	Dec.	6.	9	12.5	l 6 v, v est. 12.6.
		7.	10	12.6	l 6 v, k 11 v, v est. 12.4.
		10.	8	12.9	l 10 v, v 1 m. Seeing poor.
		14.	8	13.0	v m.
1891.	Jan.	2.	8	13.3	m 8 v. v est. between 13 and 13.5.
		4.	7	13.5	v est. 13.5, l more than mag. > v.
		6.	7	13.5	v est. 13.5.
		13.	8	13.7	v very ft.. Seeing poor. New Moon.
	Feb.	3.	7	11.9	v l. Low.

Date.			Hour.	Mag.	Observation.
1891.	Feb.	6.	7	11.4	v 3 k, g 10 v. Low.
		10.	7	<10.4	g — v. Too low for good comp.
	Sept.	12.	12	10.5	g 1 v.
		22.	9	10.8	g 4 v, v est. 11.5.
		29.	10	11.2	g 6 k, g 8 v.
	Oct.	4.	10	11.4	g 8 k, g 10 v.
		9.	10	11.5	g 8 k, v 2 k, v est. 11.0.
		19.	10	12.0	l 1 v. Bright moon.
		22.	8	12.1	l 1 — 2 v, v est. 11.5.
		27.	9	12.3	l 3 v, l 4 m.
	Nov.	2.	8	12.7	l 7 m, v est. 12.5.
		10.	10	12.9	l 10 v: Bright moon.
		17.	9	12.9	l 10 v: Bright moon.
		26.	10	13.0	v m, v est. 13.0.
		28.	10	13.1	m 1 v, v est. 13.4.
		30.	9	13.4	m 4 v, v est. 13.0.
	Dec.	4.	9	13.2	m 2 v.
		7.	11	13.0	v m: Low.
		17.	8	12.1	k 3 m, k 3 — 4 v.
		18.	7	12.3	k 5 m.
		23.	8	11.7	v k, v est. 11.4.
		26.	7	11.3	v 3 k, g 6 v.
		27.	7	11.2	v 4 k, g 7 v.
1892.	Jan.	6.	7	10.4	v g, f 6 h.
		14.	7	10.0	f 2 g, c 6 g, f 1 v.
		20.	7	9.8	c 6 g, f 2 v.
		23.	7	9.6	c 3 — 4 g, v 2 e.
		28.	7	9.4	c 3 v. Low.
	Feb.	5.	7	9.2	v c, d 3 e, d 4 v.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
	°			s	′	
a	—10, 58	7.8	7.8	—77	+ 6.2	m, 1891, Jan. 13.
b	—10, 60	8.5	8.4	—75	+ 3.1	m, 1891, Nov. 30.
c	—10, 62	9.4	9.1	—16	— 8.0	Interval, 321d.
d	— 9, 64	9.3	8.9	+14	+12.5	C. P., 322d.5.
e	— 9, 66	10.	9.9	+22	+ 9.5	
f	—10, 64	10.	9.9	— 4	+ 7.6	
g	....	....	10.4	0	— 4.0	
h	....	....	10.7	+ 2	+10.2	
k	....	...	11.7	— 6	— 1.8	
l	....	....	11.9	— 5	— 2.8	
m	....	....	13.0	—17	+ 2.2	

243. U Cassiopeae.

R. A. = $0^{h}\ 38^{m}\ 16^{s}$ Decl. = + $47^{\circ}\ 27'.8$

Date.			Hour.	Mag.	Observation.
1889.	Dec.	6.	11	9.3	v c, b 2 v.
		14.	10	9.0	v o—1 b, v 2 c.
		22.	12	9.2	v c, b 1 v.
		26.	11	8.9	a 8 b.
1890.	Jan.	7.	11	8.9	a 8 b.
	Feb.	1.	10	9.9	c 5 e, v d.
		6.	8	9.9	c 5 e: v d: v est. 10.5.
		14.	7	10.4	d 1 v, v est. 10.4.
	Mar.	8.	8	12.2	v g. Seeing poor.
		15.	8	13.0	v k, h 1 v, v g, v est. 13.5.
		21.	7	....	v, h and k very ft. Alt 15°.
		31.	7	<13.0	(v), (h), (k).
	July	15.	14	11.3	v f:
		23.	12	10.2	e 2 v, d 1 v.
	Aug.	5.	11	10·1	v d.
	Sept.	7.	9	7.9	v 3—5 a.
		22.	9	7.9	v 4 a, v 10 b.
	Oct.	17.	7	8.4	a 0—1 v.
	Nov.	10.	7	9.4	c 2 e, c 1—2 v. Seeing excellent.
		18.	7	9.8	c 6—7 e.
		23.	12	10.0	e 5 d.
		27.	12	10.1	v d.
	Dec.	6.	13	11.2	v f, d 10 v.
		10.	12	11.5	f 2 v, v 7 g.
		14.	14	11.6	f 2—3 v.
		23.	9	11.9	f 7 g.
1891.	Jan.	2.	8	12.7	g 5 v, v est. 13.

Date.			Hour.	Mag.	Observation.
1891.	Jan.	4.	8	13.0	k 5 h, v est. 13.
		13.	8	14.0	v very ft, v est. 14.
		24.	10	<11.5	(v). Full moon.
	Feb.	2.	10	<14.6	(v).
		3.	8	<14.7	(v).
		6.	8	<14.7	(v).
		10.	8	<14.7	(v).
		21.	8	<12.5	(v). Bright moon.
		25.	7	<13.0	(v).
		26.	7	<14.5	(v).
		28.	7	<14.7	(v). Seeing excellent.
	Mar.	4.	7	<14.5	(v).
		9.	7	<14.5	(v).
		11.	7	<14.5	(v).
		13.	8	<14.0	(v). New moon.
	April	4.	8	13.8	v very ft, v est. 13.8.
	Sept.	12.	9	10.8	d 6 f.
		15.	9	10.8	d 6 f.
		19.	9	11.1	d 8 f.
		22.	7	11.3	v f.
		29.	9	11.8	f 6 g.
	Oct.	4.	9	12.0	f 8 g.
		9.	9	12.9	v k, g 4 v.
		19.	8	...	k — v. Bright moon.
		20.	7	14.0	v est. 14.0.
		22.	8	14.5	v l.
		25.	8	14.5	v l.
		27.	9	14.5	v l.
	Nov.	1.	7	14.7	v vis. by glimpses.
		5.	12	14.8	Glimpse of v once.
		8.	7	<13.5	(v). Seeing poor. Half moon.
		10.	12	<13.5	(v). Half moon.

Date.		Hour.	Mag.	Observation.
1891.	Nov. 28.	11	<14.7	(v).
	Dec. 4.	12	<14.7	(v).
	6.	11	<14.7	(v).
	23.	10	<14.5	(v).
	26.	11	<14.7	(v).
	29.	8	14.2	v 3—5 l.
1892.	Jan. 6.	10	12.7	g 5 k, v 3 k, g 4 v.
	9.	8	12.5	g 3—4 k.
	14.	10	11.9	f 3 g.
	20.	10	11.2	d 9 f, v 2 f.
	21.	10	11.1	d 8 f.
	23.	8	11.0	d 8 f, v 3 f.
	26.	9	10.5	d 3 f, glimpse of v in finder.
	28.	8	10.5	d 3—4 f.
	Feb. 5.	8	9.9	v 0—1 e, v 3 d.
	11.	7	9.8	v 2 e, v 3 d. c 8 e.
	25.	9	9.0	a 5 d, v 1 b.
	Mar. 1.	9	8.9	a 4 d, a 7 b.
	8.	8	8.6	a 3 b, v 4 b, v 6 c.
	15.	8	8.3	v a, v 6 b.
	23.	7	8.3	v a, v 8 b.
	28.	8	8.3	v a, v 7 b.
	April 2.	7	8.3	v a, v 8 b.
	6.	16	8.3	v a, v 7 b.
	18.	17	8.4	a 2 b, v 8 c.
	27.	14	9.0	v b, v 3 c. Low.
	May 20.	14	9.8	b 6 d, c 5 d v 1 e.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
	°			s	′	
a	+47, 187	9.0	8.3	−30	−1.2	M, 1889 Dec. 28.
b	196	9.2	9.0	+15	+0.8	M, 1890 Sep. 16.
c	190	9.0	9.3	−21	+5.2	M, 1893 Mar. 31.
d	...	...	10.1	− 1	+2.0	m, 1891 Feb. 21:
e	186	9.5	10.0	−35	+3.4	m, 1891 Dec. 3.
f	...	...	11.3	−13	+0.5	Interval, 262d.
g	...	...	12.2	− 8	+0.4	Interval, 281d.
h	...	...	*13.0*	− 2	−1.8	Third M best of the three. See A. J. No 249. The differences are due to improved magnitudes of the comparison stars.
k	...	...	13.1	+ 6	−1.3	
l	...	...	14.5	− 4	+1.0	

434. S. Piscium.

R. A. = $1^{h}\ 10^{m}\ 0^{s}$ Decl. = $+\ 8^{\circ}\ 9'.9$

Date.			Hour.	Mag.	Observation.
1889.	Dec.	14.	9	11.5	e 1 v.
1890.	Jan.	7.	9	<13.5	(v). Bright moon.
	Feb.	8.	9	<14.0	(v). Low.
		14.	9	<14.0	(v). Low.
	Sept.	10.	15	12.8	v h.
		22.	11	12.6	v 2 h:
	Oct.	14.	10	14.0	v very ft. Seeing poor.
		18.	10	14.2	v extremely ft. Seeing poor.
	Nov.	4.	10	14.5	v vis. by glimpses. Seeing poor.
		10.	10	14.7	v vis. by glimpses.
		11.	10	14.7	v vis. by glimpses.
		18.	12	14.7	v vis. by glimpses.
	Dec.	6.	9	<14.7	(v).
		10.	8	<14.6	(v). Seeing poor.
		14.	8	<14.7	(v).
1891.	Sept.	12.	12	10.2	v c.
		22.	10	10.6	c 8 g.
	Oct.	19.	10	11.2	c 7 g, c 10 v.
		22.	8	11.3	c 8 g, v est. 11.0.
		27.	10	11.3	c 8 g, v est. 11.3.
	Nov.	2.	9	11.6	v g, v est. 11.2.
		10.	10	11.8	e 3 h.
		17.	8	12.3	e 7 h, e 7 v.
		28.	10	13.1	h 3 v.
	Dec.	4.	9	13.2	h 4 v, v est. 13.0.
		7.	11	13.8	h 10 v : Seeing poor.
		17.	8	13.8	h 10 v.
		18.	7	14.2	v est. 14.2.

Date.			Hour.	Mag.	Observation.
1891.	Dec.	26.	9	14.7	v vis. by glimpses.
		27.	9	14.7	v vis. by glimpses.
		29.	9	14.7	v vis. by glimpses.
1892.	Jan.	14.	8	<13.5	(v). Full moon.
		20.	7	<13.5	(v). Seeing miserable.
		21.	7	<14.7	(v).
		23.	7	......	Thought I saw glimpse of v.
		26.	7	<14.7	(v).
		28.	8	<14.5	(v).
	Feb.	5.	8	<13.5	(v). Moon.
		14.	7	<14.7	(v).
		15.	8	<14.5	(v). Low.
		25.	7	<14.	(v). Venus close; trace of daylight.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.			
c	.... .	. . .	10.2	$+17^s$	$-3'$	m, about 1892, February 5.
d	.....	....	10.8	+35	−3	Observations do not determine any epochs or period, but indicate a period of about 380 d.
e	.....	....	11.4	− 2	−2	
f	.....	....	11.5	+ 6	−4	C. P. 406.0 d
g	.....	....	11.6	+ 1	+2	Co ordinates of stars all taken from Chacornac's Ecliptic Charts.
h	.....	....	12.8	+10	0	

466. U Piscium.

R. A. = $1^h\ 15^m\ 18.^s$ Decl. = $+ 12^\circ\ 6.'4$.

Date.			Hour.	Mag.	Observation.
1889.	Nov.	30.	10	9.9	v 7 d, a 13 v, v 12 e.
	Dec.	12.	8	9.9	b 4 c, v 7 d.
		22.	11	9.5	v 1 b.
		24.	10	9.9	b 4 c, v 6 d.
		26.	11	10.0	b 5 c.
1890.	Jan.	7.	9	10.1	b 6 c. Bright moon.
	Feb.	8.	9	11.8	v g. Seeing poor.
		14.	7	12.5	g 3 h, g 5 v, v est. 13.
	Mar.	8.	7	<14.	(v), h just vis. Alt. 20°.
	July	15.	15	10.9	d 5 e.
		23.	14	11.2	v e.
	Aug.	19.	15	13.5	v est. 13.5.
	Sept.	10.	14	14.6	v only just vis.
		22.	11	13.8	v 2 h.
	Oct.	14.	10	11.0	d 6 e.
	Nov.	4.	10	9.8	b 3 c.
		10.	10	9.8	b 2 v.
		18.	12	9.5	v 1 b.
		20.	7	9.3	v 4 b, a 8 b.
		27.	9	9.3	v 4 b, a 8 b.
	Dec.	6.	9	9.8	b 3 v, b 3 c.
		10.	8	9.9	b 4 c.
		14.	8	10.1	b 6 c, v ft. in finder.
		23.	8	10.2	b 6–7 c.
		30.	8	10.4	v c. Seeing very bad.
1891.	Jan.	2.	8	10.6	v d, c 2 v.
		13.	7	11.2	v e.
	Feb.	3.	8	12.7	g 4 h, v est. 12.5.

Date.			Hour.	Mag.	Observation.
1891.	Feb.	6.	8	12.9	g 5 h, v est. 12.8.
		10.	7	14.0	v h, v est. 13.5.
		26.	7	14.0	v h.
		28.	7	14.5	h — v, v vis. by glimpses.
	Mar.	4.	7	14.0	v h: Seeing poor.
		9.	7	13.3	g 15 v: h not vis. Low.
	Sept.	12.	12	11.8	v g.
		22.	9	11.0	d 7 e.
		29.	10	10.3	v 1 c.
	Oct.	4.	10	10.1	b 7 c, v 4 c.
		9.	10	10.1	b 6 c, v est. 10.0.
		19.	10	9.8	b 2 c, b 8 v.
		22.	9	9.5	a 8 b, v 1 b.
		25.	9	9.6	v b.
		27.	10	9.5	a 9 b, v 1 b.
	Nov.	2.	9	9.3	a 7 b.
		5.	12	9.4	a 8 b, v 2 b.
		10.	10	9.3	a 7-8 b, v 3 b.
		17.	10	9.3	v 3 b.
		26.	10	9.8	b 2 v: Through clouds.
		28.	10	9.6	v b, a 8 v, v 6 c.
		30.	9	9.8	b 3 c, b 3 v.
	Dec.	4.	10	9.9	b 4 c, v est. 10.1.
		7.	11	9.9	b 4 c.
		12.	7	10.1	b 6 c.
		15.	8	10.2	b 8 c.
		18.	7	10.3	v 1 c, v 4 d, b 7 v.
		23.	10	10.7	d 1 v.
		26.	9	11.3	e 1 v, v 2 f.
		27.	10	11.2	v e.
1892.	Jan.	20.	7	13.8	v 2 h.
		21.	8	14.0	v h.

Date.			Hour.	Mag.	Observation.
1892.	Jan.	23.	8	14.2	h 2 v, v est. 14.4.
		24.	8	14.1	h 1 v, v est. 14.5.
		26.	8	14.2	h 2 v.
		28.	8	14.5	h 5 v, v only just vis.
	Feb.	5.	8	....	(v), (h). Half moon.
		14.	7	14.7	v vis. by glimpses; h plain.
		15.	7	14.6	v just vis. Seeing fair.
		25.	7	14.0	v h.
	Mar.	8.	7	11.7	f 5 g. Bright moon.
		15.	7	11.2	v e, d 6 v.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.	
a	+12°, 168	9.2	8.6	−26ˢ	− 6.2′	M, 1889, Dec. 17, O—C= —4d. E=21.	
b	....	10.0*	9.6	+21	+ 5.3	M, 1890, Nov. 24, O—C= —8d. E=23.	
c	....	10.7*	10.4	+38	+ 3.5	M, 1891, Nov. 8, O—C= —5d. E=25.	
d	....	11.0*	10.6	+13	− 3.9	m, 1890, Sept. 7, O—C= +4d. E=23.	
e	....	....	11.2	+11	+ 0.9	m, 1891, Feb. 22, O—C= —1d. E=24.	
f	....	....	11.5	+ 8	+ 0.1	m, 1892, Feb. 9, O—C= +5d. E=26.	
g	....	....	11.8	+10	− 1.6	Interval,	171.0.d
h	....	....	14.0	+ 7	+ 1.8	"	174.5.
						"	168.0.
						"	176.0.
						Mean interval	172.5.
						C. P.	173?
						First M and first m inferior to the others.	

* From Peters' charts.

513. R. Piscium.

R. A. = 1h 23m 10s Decl. = + 2° 7.9′

Date.			Hour.	Mag.	Observation.
1889.	Nov.	30.	10	12.1	v h. Seeing poor.
	Dec.	22.	10	<14.	(v). Hazy.
1890.	July	23.	14	9.2	a 6 v, b 3 v.
	Aug.	19.	15	9.7	v c, v 5 d. Seeing poor.
	Sept.	10.	16	10.4	v e, d 5 v.
		22.	12	11.0	d 9 v:
	Oct.	14.	10	12.1	v h, Seeing poor.
		18.	10	12.1	v h.
	Nov.	4.	10	12.4	h 3 v. Seeing poor.
		18.	12	13.8	v k, h 10–15 v.
	Dec.	6.	9	14.5	v vis. by glimpses.
		7.	9	14.7	v vis. by glimpses.
		10.	9	<14.6	(v).
		14.	8	14.7	v extremely ft.
1891.	Jan.	2.	7	<14.5	(v).
		4.	7	<14.7	(v). Seeing very good.
		5.	7	16.1	v est 16.0 or 16.2; Hall, 26 in. tel. U. S. N. Obs.
		6.	7	<14.7	(v) Seeing very good.
		18.	7	<14.5	(v).
	Feb.	3.	7	<14.0	(v). Low.
		6.	7	14.7	Just a glimpse of v.
		10.	7	14.7	v vis by glimpses.
		28.	7	13.7	v 1 k.
	Sept.	12.	13	10.7	d 8 f, d 5 v.
		22.	10	10.8	d 8 f. Moon and slight haze.
		29.	10	10.8	v 2 f.
	Oct.	4.	11	11.1	f 2 v, f 1 g; v est. 10.7.
		9.	10	11.8	f 3 g.
		19.	9	11.5	f 5 g. Bright moon.
		22.	9	11.7	f 6 g, v est. 11.5.

Date.			Hour.	Mag.	Observation.
1891.	Oct.	27.	10	11.8	f 7 g, v est. 11.6.
	Nov.	2.	9	11.8	f 7 g, v est. 11.9.
		10.	10	12.3	g 2 v.
		28.	11	13.6	v 2 k.
		30.	9	13.7	v 1 k.
	Dec.	1.	9	14.0	k 2 v: Seeing poor.
		4.	10	14.0	k 2 v, v est. 14.0.
		6.	11	13.8	v k.
		17.	8	13.7	v 1 k: Bright moon.
		18.	7	13.6	v 1–2 k.
		26.	9	13.5	v 3 k.
		29.	9	13.4	v 3–4 k, g 10 v.
1892.	Jan.	20.	7	11.9	f 8 g, v 2–3 g.
		23.	7	11.9	f 8 g, v 2 g.
	Feb.	5.	8	11.4	f 3–4 g. Bright moon.
		14.	7	11.3	f 2-3 g.
		25.	7	11.2	f 2 g, f 3 v.
	Mar.	8.	7	10.7	d 7 f, v 4 f.
		15.	7	10.6	d 5 v. Low.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	+2°, 221	8.8	8.6	− 9	+ 4.4	m, 1891 Jan. 8.
b	224	9.0	8.9	+34	+ 0.3	m, 1891, Dec. 8.
c	....	....	9.8	+45	+ 3.6	Interval 334d.
d	....	....	10.1	+ 7	+ 0.6	C. P. 344.0 d.
e	....	....	10.3	+40	+ 5.6	Minimum 16.1 or less — see observation 1891, Jan. 5.
f	....	....	11.0	+33	+ 1.7	* From a number of the comparisons it seems probable that g and h are too bright by 0.4m or 0.5m.
g	....	....	12.1*	+24	+ 0.6	
h	....	....	12.1*	+13	+ 1.2	
k	....	...	13.8	+ 7	+ 3.1	

1222. R Persei.

R. A. = $3^h\ 20^m\ 50^s$. Decl. = $+35^\circ\ 10'.1$.

Date.		Hour.	Mag.	Observation.
1891.	Sept. 13.	14	8.2	a 8 b, v 3 b, v est. 8.0.
	29.	11	8.7	v 1 d, b 4 v.
	Oct. 4.	11	8.8	v d.
	9.	11	9.0	d 3 e, d 2—3 v.
	15.	10	9.2	v e.
	23.	10	9.6	f 1 v, e 4 v.
	27.	11	9.7	f 1—2 v.
	Nov. 2.	9	10.0	f 4 v, v 2 h, v est. 10.1.
	10.	10	10.7	k 3 l, h 3 v.
	17.	10	11.2	k 6 l. Moon and clouds.
	28.	9	11.7	v l.
	Dec. 1.	8	12.0	v m, l 3 v.
	4.	9	12.4	m 2 n, m 3 v.
	7.	12	12.7	m 4 n, m 5 v.
	10.	7	12.7	m 6 v. (n.)
	18.	7	12.8	m 3 n, m 7—9 v.
	23.	7	12.7	m 3 n.
	29.	7	12.7	m 3 n, m 5 v.
1892.	Jan. 14.	6	11.0	k 5 l, k 4—5 v.
	19.	6	10.7	k 2 l, k 2 v.
	23.	11	10.4	g 8 k, v 2 k.
	26.	10	10.3	g 5 k, v h.
	Feb. 5.	10	9.8	e 8 g, v 3 g, v 8 k.
	14.	9	9.6	e 3 g, e 3 v, f 2 v.
	25.	10	9.4	e 2 v, d 6 v, v 8 h.
	Mar. 1.	10	9.3	e 5 f.
	8.	8	9.1	b 7 f, v 3 f, d 1 v.
	20.	9	8.5	b 2 d, b 2 v.

Date.	Hour.	Mag.	Observation.
1892. Mar. 23.	8	8.5	b 2 d, b 1—2 v.
27.	8	8.1	a 8 b, v 3 b, v 8 d.
Apr. 2.	9	8.1	a 7 b, v 8 d.
7.	8	8.5	a 7 d, b 3 d, b 3 v.
9.	8	8.5	a 7 d, b 3 d.
15.	8	8.6	b 4 d. v 8 f.
22.	9	8 8	v d, v 5 e, Low.
28.	8	8.9	d 3 e, b 6 e.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.			
a	+35°, 697	7.5	7.5	—74^s	+ 7.7′	
b	698	8.8	8.4	—73	+ 1.3	m, 1891, Dec. 19.
d	701	9.1	8.8	—45	+ 0.3	M, 1892, Mar. 30, O—C= —4.8^d E=17.
e	705	9.3	9.2	+18	+ 6.6	
f	707	9.4	9.5	+39	+ 1.7	
g	....	....	10.1	+ 1	+ 5.8	
h	....	....	10.2	+29	+ 4.8	
k	....	....	10.5	+13	— 1.9	
l	....	....	11.7	+21	+ 1.5	
m	....	....	12.1	+ 3	+ 1.2	
n	....	....	14.1	— 2	+ 3.0	

1577. R. Tauri.

R. A. = $4^h\ 20^m\ 21^s$ Decl. = $+9^\circ\ 50'.1$

Date.			Hour.	Mag.	Observation.
1890.	Oct.	20.	13	8.3	v 5 b. v est. 8. 5.
1891.	Sept.	13.	15	8.4	a 3 v.
		23.	15	8.5	a 6 b.
		29.	16	8.9	b 2 v,
	Oct.	9.	15	9.0	b 2 c, b 3 v.
		15.	15	9.1	b 3 c.
		24.	14	9.3	b 4–5 c. Air rather thick.
	Nov.	4.	15	9.5	b 6—7 c, v 5 c, v est. 9. 5.
		10.	12	9.6	b 7 c, v 3—4 c. Seeing poor.
		17.	12	9.8	v 2 c.
		28.	13	9.8	v 2 c.
	Dec.	1.	10	10.0	v c.
		4.	10	10.0	v 1 c, v 4 d.
		7.	12	10.2	c 5 d.
		10.	11	10.2	c 3 d.
		15.	10	10.1	c 2 d.
		23.	9	10.2	c 6 d, v 4 d.
		26.	11	10.4	c 8 d, v 2 d.
1892.	Jan.	6.	11	10.2	v 3—4 d.: Clouds.
		14.	10	10.4	c 8 d, v 2 d.
		20.	10	10.9	e 2 v, d 4 v.
		23.	8	11.3	e 4 v, e 3 f.
		28.	8	11.2	e 4—5 v, e 2 f, d 3 f.
	Feb.	11.	8	11.6	e 8 v:: Full moon.
		14.	8	12.1	d 7 f, v 4—5 f.
		25.	9	12.7	v f.

Date.			Hour.	Mag.	Observation.
1891.	Mar.	1.	9	12.9	f 2 v: Seeing bad.
		8.	8	12.7	v f: Moon.
		15.	8	12.7	v f.
		20.	8	12.6	e 9 f, v 1 f.
		23.	8	12.3	e 8 f.
		24.	8	12.2	e 7—8 f.
		27.	8	12.1	e 7 f.
	Apr.	2.	8	11.5	e 7 v: Moon.

COMPARISON STARS.

*	B. D.	Mag.		Co ordinates.		Remarks.
		B. D.	T.	s	′	
a	+9°, 584	7.8	8.1	—15	—5.7	m, 1892, March 6.
b	583	8.3	8.7	—26	—9.6	Observations indicate a secondary M on
c	....	....	10.0	—26	—9.1	1891, Dec. 17.
d	....	....	10.5	+ 2	+1.9	
e	....	....	10.8	+32	+0.5	
f	....	....	12.7	—19	+0.4	
g	....	....	14.3	—15	+1.1	

1582. S Tauri.

R. A. = $4^h\ 21^m\ 16^s$ Decl. = $+\ 9^\circ\ 37'.3$

Date.			Hour.	Mag.	Observation.
1890.	Oct.	20.	13	14.	v est. 14:
1891.	Sep.	13.	15	13?	v h: :
	Oct.	24.	8	13.0	v h:
	Nov.	4.	15	11.4	v e: v f:
		10.	12	11.0	v 2 e:
		17.	12	10.0	v 2 d.
		28.	13	9.1	a 6 b, v 3 b.
	Dec.	1.	10	9.1	a 6 b. Seeing poor.
		4.	11	9.1	a 6 b.
		7.	12	9.1	a 6 b.
		10.	11	8.9	a 4 b.
		15.	10	9.0	a 5 b.
		23.	10	9.1	a 6 b.
		26.	11	9.1	a 6 b.
1892.	Jan.	6.	10	9.1	a 6 b, v 5 b.
		14.	10	9.2	a 7 b, v 4 b.
		20.	10	9.4	v 2 c, b 1 v.
		23.	10	9.6	b 5 d, v c.
		28.	8	9.7	b 4 d, c 2 d, c 2 v.
	Feb.	5.	10	9.8	b 5 d, c 3—4 d, c 4 v.
		11.	8	9.8	b 6 d, c 4 d.
		14.	8	9.8	c 4 d, c 3 v.
		25.	10	10.3	c 6 e, v d.
	Mar.	1.	9	10.5	d 3 e, d 3 v.
		8.	8	10.6	d 5–6 e, c 7–8 v.
		15.	8	10.9	d 7 e.

Date.	Hour.	Mag.	Observation.
20.	8	10.9	d 7 e, v 2–3 e.
23.	8	11.6	v f, v 7 g.
24.	8	11.6	v f, e 5 v.
27.	8	11.7	e 5 g, f 1 v.
Apr. 2.	8	12.1	f 4–5 v, f 8 g.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co ordinates.		Remarks.
				s	′	
a	+9°, 583	8.3	8.6	−82	+ 3.4	M. 91, Dec. 18; O—C=—37d E=8. Tendency toward a secondary M 1892, Feb. 15.
b	589	9.5	9.4	+35	+0.3	Observations indicate a period of about six months.
c	588	9.5	9.5	+16	−5.0	C. P., 376d.
d	....	....	10.2	− 7	−4.7	h possibly variable, estimates as follows:
e	....	....	11.2	+11	−2.2	1891, Dec. 4. 12.1 m
f	....	....	11.6	+ 6	−2.2	Dec. 26. 12.8.
g	....	....	12.4	+25	−0.6	1892, Jan. 23. 13.0. Mar. 20. 13.0.
h	....	....	13.	+10	−0.2	Mar. 23. 13.8.

1717. V. Tauri.

R. A. = $4^h\ 43^m\ 39^s$ Decl. = + $17^\circ\ 17'.4$

Date.			Hour.	Mag.	Observation.
1891.	Sept.	18.	16	9.2	v c, d 1 v.
		28.	15	9.0	a 8 d, v 8 b.
		29.	16	8.7	a o–1 v.
	Oct.	9.	15	8.7	a 1 v.
		15.	16	8.5	v 1 a.
		24.	15	8.7	a 2 v, a 2 d.
	Nov.	4.	15	8.7	a 1 v, a 2 d.
		10.	12	8.7	a 1 v. Images diffuse. v orange red.
		17.	12	8.7	a 1 v.
		28.	13	9.0	a 2 v, v c.
	Dec.	4.	11	9.2	v c.
		6.	12	9.6	d 2 e.
		10.	11	10.8	d 6 e.
		15.	10	10.6	d 8 e.
		23.	10	11.2	e 2 f.
		26.	11	11.3	e 2–3 f.
1892.	Jan.	20.	11	13.0	g 2 h, g 3 v.
		23.	11	13.3	g 4 h, g 5 v.
		28.	8	12.7	v g. Light clouds.
	Feb.	11.	8	12.0	v f, e 6–7 g.
		14.	9	11.7	e 8 f.
		25.	10	11.0	d 7 f, v e.
	Mar.	1.	9	10.9	d 6 f, v 1 e.
		8.	8	10.3	d 6 e, v 6 e.
		15.	9	10.3	d 6 e.
		20.	9	10.3	d 6 e, v 5 e.
		28.	9	9.8	d 4 e, c 4 v.

Date.	Hour.	Mag.	Observation.
24.	9	10.1	d 5 e.
27.	8	9.3	d 2 e, c 1 v, v b.
Apr. 2.	8	9.2	a 9 c, b 1 v, v d.
7.	8	9.0	a 7 d, v 1 b, v 3 c.
15.	8	8.8	a 6 d, v 4 b, v 5 c.
22.	9	8.9	a 7 d, v 4 c. Alt. 15°.
28.	8	9.2	v d, v 1 c, b 1 v.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	+17°, 797	9.0	8.6	−12	+8.5	M, 1891, Oct. 20. O−C= + 27.d 6 E=17.
b	796	9.4	9.1	−21	−7.2	M, 1892, Apr. 16. O−C= +37.d 4 E=18.
c	801	9.5	9.2	+15	+9.0	m, 1892, Jan. 28.
d	799	9.5	9.2	− 5	+7.7	Interval 179d.
e	... .	....	11.0	+12	+3.7	C. P: 169.2.
f	....	....	11.9	0	+4.2	First M very flat, 8.5m.
g	... .	....	12.7	− 7	+2.4	Second M very sharp, 8.7m.
h	....	....	14.4	− 1	+0.7	m, very sharp.

1761. R Orionis.

R. A. = $4^h\ 51^m\ 8^s$ Decl. = + $7°\ 54'.3$

Date.			Hour.	Mag.	Observation.
1891.	Sept.	13	16	8.7	v 3 a, v est. 9.0.
		23	15	8.5	v 5 a.
		29	16	8.9	v 1 a.
	Oct.	9.	15	8.9	v 1 a.
		15.	15	9.0	v a.
		21.	15	9.1	a 2 b, a 1 v.
	Nov.	4.	16	9.3	a 6 b.
		10.	13	9.3	a 5 b, v 2 b.
		17.	12	9.5	v b.
		28.	13	10.2	v 1 c, b 7 v. v est. 10.1.
	Dec.	1.	12	10.3	v c.
		4.	11	10.3	v c.
		6.	12	10.3	v c.
		10.	11	10.1	v 2 c, a 8 c. Verified.
		15.	11	10.1	b 7 c. Verified.
		23.	11	10.6	c 3 v.
		26.	12	10.6	c 3 d.
1892.	Jan.	8.	9	10.6	c 3 d, c 4 v.
		14.	10	10.6	c 3 d: Moon. Clouds.
		20.	11	10.9	c 6 d, v 6 d.
		23.	11	11.1	c 7 d.
		24.	9	11.1	c 7 d.
		28.	9	11.1	c 7 d, v 4 d.
	Feb.	5.	10	11.1	c 6–7 d:
		14.	8	11.2	c 8 d, c 7 e, v 2 d.
		25.	10	10.4	v c, v 8 d. Apparently good.
	Mar.	1.	10	11.0	c 6 d. Verified.

Date.	Hour.	Mag.	Observation.
8.	9	10.1	b 8 c, v 3 c. Verified.
15.	9	10.1	b 7 c.
20.	8	9.9	b 5 c.
23.	8	9.7	b 3 c.
24.	8	9.7	b 2 c.
27.	8	9.7	b 2 c, b 2–3 v.
Apr. 2.	8	9.5	a 3–4 c. v b.
9.	8	9.2	a 3 b, a 2 v.
15.	8	9.2	a 3 b, a 2 v.

COMPARISON STARS.

*	B. D.	Mag.		Co ordinates.		Remarks.
		B. D.	T.	s	′	
a	+7°, 766	9.5	9.0	−19	−11.3	m, 1892, Feb. 3.
b	767	9.5	9.5	−11	− 3.9	Secondary M, 1891, Dec. 13.
c	....	...	10.8	−27	− 1.6	Flattening of the curve follows the secondary M.
d	....	...	11.4	− 7	+ 0.5	
e	....	...	11.8	− 7	− 0.9	
g	....	...	13.4	−13	− 0.9	
n	....	...	14.5	− 5	− 0.7	

1944. S Orionis.

R. A. = $5^h\ 21^m\ 51^s.$ Decl. = $-4^\circ\ 48'.7.$

Date.		Hour.	Mag.	Observation.
1891.	Nov. 28.	12	10.0	v d, v 1 e, v red.
	Dec. 23.	11	10.4	v f.
	26.	12	10.2	v 1 f, d 2 v.
1892.	Jan. 8.	9	10.6	f 5 g, d 4 v.
	20.	10	10.8	f 5 g, d 7 g.
	23.	11	11.0	f 7 g.
	24.	9	10.9	f 6 g.
	28.	9	11.0	f 8 g. v 1 g.
	Feb. 5.	10	10.6	f 2 g. Verified.
	14.	8	10.4	v f: Seeing poor.
	25.	10	10.3	v f, c 4 g.
	Mar. 1.	10	10.6	f 3 g, f 2-3 v.
	8.	8	10.2	e 5 f, v 3 f.
	20.	9	9.8	v d, v 6 e.
	23.	9	10.0	d 2 v, d 3 e.
	24.	8	9.9	v d, c 6 v.
	Apr. 2.	8	9.6	c 6 d, v 7 e.
	9.	8	9.5	b 7 d, v 6 d, v c.
	15.	8	9.4	b 8 v, v 5 d, v c.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
	°			s	'	
a	—4, 1141	7.5	7.7	—26	— 0.9	m, 1892, Jan. 25, O—C=—77d.
b	1147	9.1	8.7	+13	— 7.7	E=20.
c	1144	9.4	9.4	— 2	— 0.8	
d	1145	10.	9.9	— 0	+ 0.6	
e	....	....	10.1	+14	— 1.2	
f	....	....	10.4	+ 4	+ 3.2	
g	....	....	11.2	+ 3	— 2.9	
h	....	....	12.5	— 2	+ 1.7	

2478. R Lyncis.

R. A. = $6^h\ 49^m\ 20^s$ Decl. = $+55^\circ\ 31'.6$.

Date.		Hour.	Mag.	Observation.
1891.	Sept. 13.	15	9.8	d 3 v. v est. 9.8.
	23.	14	9.9	d 3 f.
	Oct. 2.	16	10.1	d 5 f, d 10 v.
	9.	11	10.3	d 6 f, d 10 v. v est 10.7.
	15.	9	10.3	d 7 f.
	23.	10	10.6	d 9 f, v 2 f.
	28.	10	10.7	f o–1 v. Seeing poor.
	Nov. 2.	9	10.9	f 1–2 v.
	10.	11	11.0	f 3 v.
	17.	11	11.3	f 5–6 v.
	28.	9	11.7	f 10 v.
	Dec. 1.	8	11.9	v g, f 10 v.
	4.	9	11.9	v g.
	7.	12	12.7	g 5 h. v est 13.2.
	10.	7	13.0	v 5 h: Bright moon.
	18.	7	13.5	v h.
	23.	7	13.7	h 2 v, v est 14.
	26.	8	13.5	v h.
	29.	7	14.1	v k, h 5 v.
1892.	Jan. 6.	10	14.1	v k, h 5 v. Moon.
	19.	6	12.5	g 4 h.
	20.	10	12.5	g 4–5 h.
	23.	11	12.9	g 6 h.
	26.	10	11.5	f 7 g.
	Feb. 5.	8	10.3	d 5 f, v e.
	9.	7	10.0	d 6 e, c 8 e.
	15.	7	9.4	v d, c 2 v, v 10 e.
	25.	11	9.0	c 2 d, c 2 v.

Date.	Hour.	Mag.	Observation.
Mar. 8.	9	8.6	b 7 c, v 5 c.
20.	12	8.6	b 6–7 c, v 4 c.
23.	11	8.4	b 2–3 c, v 5 c.
27.	11	8.6	b 7 c, v 4 c. Verified.
Apr. 2.	9	8.4	b 4 c, v 7 c.
9.	10	8.3	b 2 c, b 1–2 v. v yellow.
15.	9	8.0	a 8 b, v 10 c.
22.	10	7.8	a 7 b.
28.	11	7.8	a 6–7 b.
May 23.	10	7.2	a 1–2 b, a 2 v.
June 11.	9	7.0	v a.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co ordinates.		Remarks.
	°			s	′	
a	+55, 1155	7.0	7.0	+3	—28.1	m. 1892, Jan. 1. O—C=+16.0 d
b	1150	8.5	8.2	—69	+26.0	E=8.
c	....	....	8.9	+25	+2.0	
d	....	....	9.5	—8	+3.7	
e	....	....	10.4	—30	+1.2	
f	....	....	10.7	+7	—1.5	
g	....	....	11.9	—20	+0.2	
h	....	....	13.5	+3	—1.2	
k	....	....	14.2	—8	—0.7	

2528. R Geminorum.

R. A. = $6^h\ 58^m\ 37^s$. Decl. = + $22°\ 55'.4$.

Date.			Hour.	Mag.	Observation.
1889.	Dec.	30.	16	... .	v <10m.5.
1891.	Oct.	2.	16	9.7	d 4 g.
		9.	17	10.1	d 6 g.
		15.	17	10.3	d 7 g.
		24.	17	10.3	d 7 g.
	Nov.	4.	16	10.5	d 9 g.
		10.	18	10.5	d 9 g.
		17.	12	10.5	v f, v 3 g.
		28.	18	10.9	g 1 v, v est. 11.0.
	Dec.	1.	18	11.2	g 5 k.
		4.	11	11.2	g 5 k.
		6.	12	11.3	g 6 k.
		10.	11	11.3	g 6 k.
		17.	10	11.3	g 6 k.
		27.	10	11.6	v k, g 7 v.
1892.	Jan.	8.	10	12.1	v l, k 5 v.
		20.	11	12.0	k 7 l, v 2—3 l.
		23.	11	12.2	v l, k 8 v.
		26.	10	12.3	l 2 m, l 2 v.
	Feb.	5.	11	12.5	l 4 m, l 3—4 v.
		14.	10	12.5	l 5 v, v 7 m.
		15.	7	12.4	l 3 m, l 3—4 v.
		25.	11	12.1	v l, k 5 v.
	Mar.	1.	11	11.7	v k, v 4 l, k 5 l.
		8.	9	11.5	h 7 k, v 3 k.
		15.	9	11.4	h 2 k.
		20.	12	11.2	f 7 k, v 3—4 k.

Date.			Hour.	Mag.	Observation.
1892.	Mar.	23.	11	11.0	f 6 k, g 2 k, g 2 v.
		27.	9	10.7	e 3 k, v g.
	Apr.	2.	8	10.1	c 9 e, v 2 e, v 10 g. v orange.
		9.	10	9.4	c 3 e, d 5 v. v red.
		15.	9	8.6	v 2 c, v 4 d.
		22.	9	8.8	b 4 c.
		28.	9	8.1	a 7 c, v b.
	May	15.	9	7.6	a 6 b.
		23.	10	7.2	a 2—3 b.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	+22°, 1566	7.1	*6.9*	—122	—2.6	m, 1892, Feb. 7, O — C = — 36.d 0.
b	+22, 1569	8.5	*8.0*	— 67	—0.5	E = 14.
c	+23, 1604	9.0	8.8	+ 4	+7.6	Only one estimate of h and that is g 5 h.
d	+22, 1581	9.1	9.1	+ 25	+3.6	
e	....	....	10.3	+ 8	+6.5	
f	....	....	10.4	+ 16	+6.4	
g	....	....	10.8	— 5	—2.7	
h	....	....	11.3	— 17	0.0	
k	....	....	11.6	+ 2	+1.7	
l	....	...	12.1	— 2	—1.0	
m	....	....	13.1	— 9	—1.1	
n	....	....	14.4	— 7	—0.6	

2684. S Canis Minoris.

R. A. = $7^h 24^m 51^s$ Decl. = $+ 8° 37'.4$

Date.			Hour.	Mag.	Observation.
1889.	Dec.	30.	11	12.7	v est. 12.5 or 13.0:
1891.	Oct.	9.	17	9.9	e 6 f.
		15.	17	9.9	e 7 f, v 4—5 f.
		19.	16	10.0	e 7 f, v 3—4 f.
		24.	16	10.1	e 8 f, v 3 f.
	Nov.	10.	13	10.2	e 9 f, v 2 f.
		17.	12	10.3	v f.
		28.	13	10.3	v f. v just vis. in finder.
	Dec.	1.	13	10.5	f 2 g, f 2 v.
		4.	12	10.3	v f. v est. 10.3,
		6.	13	10.4	f 1 g, f 1 v.
		10.	11	10.2	v 1 f. Verified.
		17.	10	10.0	e 7 f, v 3—4 f.
		25.	10	9.9	d 7 f, v 4 f.
		27.	11	9.8	a 4—5 f: Clouds.
1892.	Jan.	8.	10	9.4	e 1 f, e 2 v.
		20.	11	9.0	d 3 e, d 2 v.
		23.	11	9.0	d 3 e, d 3 v.
		28.	9	8.9	d 1 e, d 2 v.
	Feb.	5.	11	8.5	v 3 d. v 7 e.
		14.	10	8.2	v 6 d, v 10 e.
		25.	10	....	v 9 d.
	Mar.	1.	10	8.0	v 10 d, c 1 v.
		8.	9	7.9	b 2 c.
		20.	11	7.7	v 1 b, v 5 c.
		23.	9	8.1	b 7 c: Probably wrong comp. stars.
		24.	9	8.1	b 7 c. Probably wrong comp. stars.

Date.		Hour.	Mag.	Observation.
1892.	Mar. 27.	8	7.8	v b, a 6 c.
	Apr. 2.	8	7.6	a 7 b, v 6—7 c.
	9.	8	7.6	a 6 b, a 4 c.
	15.	9	7.6	a 7 b, a 4 c.
	22.	9	7.6	a 6 b, a 4 c.
	28.	8	7.6	a 6 b, a 4 c.
	May 15.	8	8.0	b 2 d, v 1 c.
	25.	9	8.4	c 3 d. Alt. 15°.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.			
a	+8°, 1791	7.8	7.2	-108^s	$+13'.4$	m, 1891, Dec. 1.
b	1816	8.2	7.8	+157	+12.4	M, 1892, Apr. 15, O – C = –12d, E = 14.
c	1801	8.5	8.2	+ 3	+20.0	
d	1805	9.5	8.8	+ 19	+ 4.4	
e	1799	9.3	9.3	– 25	+ 3.1	
f	....	....	10.3	– 14	+ 3.3	
g	....	....	11.0	+ 3	– 2.0	
h	....	....	12.1	– 7	+ 2.7	
k	....	....	13.6	– 8	+ 0.3	
l	....	....	14.8	– 1	+ 0.5	

2742. S. Geminorum.

R. A. = $7^h\ 34^m\ 20^s.$ Decl. = $+23^\circ\ 47'.2.$

Date.			Hour.	Mag.	Observation.
1889.	Dec.	30.	16	9.1	a 7 b.
1891.	Oct.	19.	16	10.5	v 3 d.
		24.	17	10.8	v d.
	Nov.	10.	13	11.8	v e.
		17.	13	....	v e :: Moon.
		28.	14	12.3	e 5 v:
	Dec.	1.	18	14.0	v only just vis. v est. 14.
		4.	12	12.1	c 3 v.
		6.	13	12.2	e 6 f.
		10.	12	12.2	v 3 f:
		25.	12	....	v some ftr. f. Seeing bad.
		27.	11	12.5	v f.
1892.	Jan.	6.	10	....	f 3 g :: Br. moon.
		20.	11	14.5	g—v, v vis. by glimpses, v est. 14.5.
		23.	11	14.2	v g.
		26.	11	13.7	f 7 g.
	Feb.	5.	11	13.0	f 5 v, (g)
		15.	8	13.0	f 3 g, f 4 v.
		25.	11	12.6	f 1–2 v, e 8 v.
	Mar.	1.	11	12.5	v f.
		15.	9	11.9	v e, v 5 f.
		20.	11	11.6	d 8 e.
		23.	11	11.4	d 6 e.
		27.	9	10.9	c 6 e, d 0–1 v.
	Apr.	2.	9	10.6	c 3 e, c 9 d.
		9.	9	10.3	c 3-4 d.
		15.	10	9.8	b 8 c, v 2 c.

Date.		Hour.	Mag.	Observation.
1892.	Apr. 22.	10	9.4	b 2 c.
	28.	8	9.1	a 8 c, v 1 b.
	May 15.	9	8.9	a 4 b, a 3 v.
	23.	9	8.9	a 4 b, a 4 v.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	+23°, 1797	8.5	8.6	+ 7	+5.9	m, 1892 Jan. 18.
b	1798	9.5	9.3	+16	−1.8	
c	...	...	10.0	−19	+1.6	
d	....	...	10.8	+ 4	−0.8	
e	...	...	11.8	− 1	+1.0	
f	....	...	12.5	−11	+1.8	
g	....	...	14.2	− 1	+2.9	

5430. T Librae.

R. A. = $15^h\ 2^m\ 28^s$ Decl. = $-19^\circ\ 27'.8$

Date.		Hour.	Mag.	Observation.
1890.	Apr. 19.	13	14.2	v very ft, d—v:
	May 13.	12	<14.5	(v).
	26.	14	<14.3	(v). Seeing very bad.
	June 6.	11	<14.6	Thought once I caught a glimpse of v.
	7.	11	<14.5	(v). Seeing poor.
	15.	10	<14.7	(v).
	July 8.	9	14.7	v vis. by glimpses.
	9.	10	14.7	v extemely ft. Seen by three other persons.
	10.	10	14.6	v vis. by glimpses. Seeing poor.
	15.	9	14.7	v vis. by glimpses.
	20.	9	14.4	v vis. continually but very ft.
	Aug. 4.	9	11.9	v c, v est. 12.5 or 13. Low.
	17.	8	10.9	b 5 c.
	19.	8	10.8	b 10 v.
	Sept. 6.	8	9.8	v b. Seeing poor. Low.
	16.	7	9.2	v a, v 5 b.
1891.	Jan. 13.	18	<14.5	(v).
	Feb. 3.	17	<13.5	(v). Last quarter moon.
	5.	15	<14.5	(v). Seeing poor.
	18.	17	<14.6	(v).
	Mar. 11.	16	14.3	v est. 14.0-14.5.
	Apr. 4.	16	11.9	v c.
	11.	16	10.1	b 2 v, v est. 10.7.
	15.	15	9.6	v 2 b,
1892.	Mar. 27.	15	14.7	v just vis.
	Apr. 6.	16	<14.4	(v). Seeing poor.
	18.	14	<14.0	(v). Half moon rising.

Date.		Hour.	Mag.	Observation.
1892	Apr. 22.	12	<14.7	(v.)
	27.	12	<14.7	(v).
	28.	12	<14.7	(v).
	May 15.	10	<14.5	(v). Seeing poor.
	20,	12	<14.7	(v).
	23.	11	<14.7	(v).
	25.	10	<14.7	(v).
	June 11.	10	<13.	(v). Full moon. Clouds.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.	Remarks.
		B. D.	T.		
a	-19°, 4039	9.5	9.1	-28^{s} $-6.5'$	m, about 1890, June 5.
b	4042	10.	9.8	+ 8 − 1.1	m, about 1891, Feb. 1.
c	.. ..	....	11.9	− 8 + 0.3	m, about 1892, May 10.
d	....	....	12.6	− 5 + 0.7	Intervals 241^{d} and 233^{d}.
					C. P. 723^{d}.
					Invisible for over two months.

5494. S. LIBRAE.

R. A. = $15^h\ 13^m\ 4^s$ Decl. = $-19^\circ\ 51.'7$.

Date.		Hour.	Mag.	Observation.
1890.	Apr. 20.	12	9.0	v est. 9.0:
	July 8.	10	10.3	v just vis. in finder.
	Sept. 10.	8	8.0	v est. 8.
	16.	9	...	v brighter 8.
1891.	Apr. 4.	16	7.6	v 15 a:
	15.	16	7.6	v 15 a:
1892.	Mar. 27.	16	8.9	v 2 a.
	Apr. 9.	16	8.5	v 6 a, v 10 b.
	18.	14	8.5	v 6 a, v 9 b.
	22.	13	8.5	v 6 a, v 10 b.
	27.	13	8.4	v 7 a, v 10 b.
	28.	13	8.4	v 7 a, v 11 b.
	May 15.	11	8.1	v 10 a.
	20.	13	8.1	v 10 a, v 14 b.
	25.	11	8.1	v 10 a.
	June 11.	10	8.4	v 7–8 a.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
a	-19°, 4082	9.3	9.1	-18^s	$-4.'1$	M, 1892, May 20, O − C = + $9.^d1$, E = 23.
b	4083	9.5	9.5	−13	−6.7	Observation of 1890, Sep. 10., must have been about on M.
c	....	....	11.6	−20	−1.5	
d	....	....	11.4	+ 6	+2.0	Possibly comparison star e is variable.
e	....	...	12.1	− 2	+1.8	

5583. X Librae.

R. A. = $15^h\ 27^m\ 50^s$ Decl. = $-20^\circ\ 40'.8$.

Date.		Hour.	Mag.	Observations.
1890.	April 19.	13	11.4	d 7 e.
	May 26.	14	14.0	l—v. Seeing bad.
	June 7.	10	13.5	v l, v—m.
	15.	10	12.3	v f, v 1 g, e 5—7 v.
	July 8.	10	10.5	c 7 d, v est. 10.6.
	20.	10	10.0	v b, c 5 v, v est. 10.8.
	Aug. 4.	9	9.9	v 0--1 b, c 3—4 v. Seeing poor.
	17.	9	....	v b. Seeing poor.
	19.	9	10.0	v 0—1 b, c 5—7 v.
	Sept. 7.	8	10.4	b 7 d, b 7—9 v. Low.
1891.	Jan. 13.	17	9.5	v 0—1 a, v 3 b.
	Feb. 3.	18	9.6	a 5 b.
	18.	18	9.7	a 8 b.
	Mar. 11.	17	10.7	v d.
	Apr. 9.	17	13.5	h 5 m:
	11.	18	<13.5	(v). Daylight coming.
	15.	16	14.5	v vis. by glimpses.
1892.	Mar. 27.	15	14.6	v only just vis.
	Apr. 18.	14	13.1	v f, (d 2 h).
	22.	12	11.6	v e, d 6 v.
	27.	13	10.6	v d, c 3 e.
	28.	13	10.6	v 2 d, c 5 e.
	May 15.	11	10.0	c 0—2 v, b 3 d.
	20.	12	10.0	c 1 v, b 3 d.
	25.	11	9.9	c 1 d, b 2 d.
	June 11.	10	9.9	v 0—1 c, b 2 d.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
a	-20°, 4272	9.8	9.6	-22^s	$+9'.2$	m, 1890, May 22.
b	4276	9 8	9.7	+12	+3.5	M, 1890, Aug. 6, O—C = − 42ᵈ, E = 15.
c	4271	10.	9.9	−23	+6.1	M, 1891, Jan. 22, O—C = − 168ᵈ, E = 16.
d	....	....	10.7	−31	+8.6	Interval 169ᵈ.
e	....	....	11.7	+13	−1.8	C. P. 295.
f	....	...	12.1	−17	+2.9	With period 169ᵈ.
g	....	....	12.8	−16	+1.7	O—C = −11ᵈ. E = 27.
h	....	....	13.0	+ 1	+1.7	
l	....	...	13.5	+ 4	+0.3	
m	....	....	14.1	+ 0	+0.7	

5795. W Scorpii.

R. A. = $16^h\ 3^m\ 18^s$, Decl. = $-19°\ 45'.3$.

Date.			Hour.	Mag.	Observation.
1890.	Apr.	20.	13	10.9	v c, b 2 v, v est. 11.3.
	June	6.	11	11.9	c 4 e, v est. 12.
		15.	10	13.2	v e, v est. 12.5 or 12.8.
	July	9.	11	14.5	v very ft., v est. 14.5.
		10.	10	14.5	v very ft.
		12.	10	14.6	v just vis.
		15.	10	14.6	v extremely ft.
		21.	10	<14.5	(v). Seeing poor.
	Aug.	4.	10	<14.5	(v). Seeing poor.
		5.	10	<14.6	(v).
		17.	9	<14.5	(v). Seeing poor.
		19.	9	14.7	v vis. by glimpses.
	Sept.	6.	9	<14.3	(v). Low.
		16.	9	14.6	v vis. by glimpses.
1891.	Feb.	5.	17	14.3	v f.
	Mar.	11.	17	<14.5	(v). Seeing poor.
	Apr.	9.	17	14.6	v vis. by glimpses.
		15.	16	14.6	v vis. by glimpses.
1892.	Mar.	27.	16	11.9	c 4 e.
	Apr.	9.	16	12.7	c 3 e, v 5 d.
		18.	14	13.8	d 7 f, e 7 v.
		22.	13	14.0	v 2 f, d 3 v.
		27.	13	14.4	f 1 v, v est. 14.6.
		28.	13	14.5	f 2 v, v est. 14.7.
	May	15.	11	<14.7	(v).
		20.	13	<14.7	(v).
		25.	11	<14.7	(v).
	June	11.	10	<13.0	(v) d vis. by glimpses. Full moon.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
				s	′	
a	—19°, 4331	9.8	9.6	+11	—2.8	m, 1890, Aug. 15. Uncertain.
b	....	....	10.6	+16	+4.8	m, 1891, Mar 15. Uncertain.
c	....	....	11.0	+23	—2.6	Interval, 212d.
d	....	....	13.0	+4	—1.0	C. P., 224.3.
e	....	....	13.2	—4	—1.0	m, uncertain to the extent of a week or
f	....	....	14.3	+4	+0.9	more.

6905. R Sagittarii.

R. A. = $19^h\ 8^m\ 11^s$. Decl. = $-19^\circ\ 33'.5$.

Date.		Hour.	Mag.	Observation.
1890.	Aug. 17.	11	8.8	v b, v est. 8.5. Seeing poor.
	Sept. 9.	9	8.7	v 1 b.
	21.	11	8.4	v 4 b, v 10 c, Seeing very poor.
	Oct. 14.	7	7.6	a o–1 v, v 10 b.
	20.	7	7.1	v 4 a.
	Nov. 4.	7	7.9	a 3 b, a 5–7 v.
	10.	8	8.2	a 5 b: Low.
	11.	7	8.2	a 5 b, v est. 8.5.
	13.	7	8.3	a 6 b.
	19.	7	8.5	a 8 b, v 3 b.
	23.	7	8.6	v 2 b. Alt. 12°.
	28.	7	8.7	v 1 b: Alt. 10°.
	Dec. 8.	7	9.1	b 5 c: Low. Seeing poor.
	14.	6	9.2	b 7 c, Alt. 20°.
1891.	Sept. 12.	8	9.2	b 7 c.
	15.	7	9.3	b 8 c, v 2 c.
	19.	7	9.3	b 9 c, v 1 c.
	22.	8	9.6	c 3 d, c 2 v.
	29.	9	9.8	c 7 d, c 5 v.
	Oct. 4.	9	10.1	v e, d 2 v, v est. 10.0. Alt. 25°.
	7.	7	10.2	v e.
	9.	7	10.3	e 1 v.
	15.	8	10.5	e 4 f. Full moon.
	19.	7	10.9	v 0–1 f.
	23.	7	11.1	f 1 v, e 7 v.
	25.	8	11.2	f 2 v.
	28.	7	11.1	f 0–1 v.

Date.			Hour.	Mag.	Observation.
	Nov.	2.	7	11.1	f 1 v.
		10.	7	11.7	f 4 v, v h.
		17.	6	11.9	f 5 v, h 0–1 v.
		18.	6	12.0	v h.
		24.	6	12.2	h 2 v.
		28.	6	12.3	h 3 v, Alt. 15°
		29.	6	12.3	h 3 v.
	Dec.	5.	6	12.3	h 3 v.
		10.	6	....	v — h: Low.
1892.	Apr.	6.	16	7.4	v 2 a, v 10 b.
		18.	15	7.6	a 1 v, v 10 b.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co ordinates.		Remarks.
	°			s	′	
a	—19, 5387	8.0	7.5	+91	+26.7	M, 1890, Oct. 22, O—C=—44d E=29. m, 1891, Nov. 30. Uncertain on account of poorness of last observation. First two sets of observations indicate a period of 272 days which, with the epoch 1890, Oct. 22, would give a M 1892, Apr. 14, but the two observation in April indicate that the M probably came in the last part of March.
b	5375	9.1	8.8	+43	+6.3	
c	5368	9.3	9.4	+10	+5.5	
d	5366	9.5	9.9	—1	+4.6	
e	....	....	10.2	—4	+1.6	
f	....	....	11.0	—1	—0.7	
g	....	....	11.1	—12	+0.9	
h	....	...	12.0	—14	—0.1	

6921. S Sagittarii.

R. A. = $19^{h}\ 10^{m}\ 57^{s}$. Decl. = $-19^{\circ}\ 17.1'$.

Date.		Hour.	Mag.	Observation.
1890.	Aug. 5.	9	12.1	c 5 e, v est. 13.
	17.	11	11.9	c 5 e. Seeing poor.
	Sept. 9.	9	10.2	b 2 c. Seeing poor.
	Oct. 14.	7	9.6	a 8 b, v 5 b, v est. 9.5.
	20.	7	9.9	b 0–1 v.
	Nov. 4.	7	10.4	b 5 c, b 5 v, v est. 10.5.
	11.	7	10.4	b 5 c. Seeing poor. Alt. 25."
	13.	7	10.6	b 7 c.
	19.	7	10.9	v c: Br. moon.
1891.	Sept. 22.	7	14.5	v exceedingly ft. v est. 14.5.
	29.	9	14.0	v very ft. v est. 14.0.
	Oct. 4.	9	13.5	v est. 13.5.
	9.	7	13.5	v 2–3 f. Moon.
	19.	7	12.5	v d, v 5 e.
	23.	7	11.9	c 5 e.
	25.	7	11.9	c 5 e.
	28.	7	11.7	c 4 e. Hazy.
	Nov. 2.	7	11.3	c 2 e. v est. 11.0.
	10.	7	10.8	v 0–1 c.
	17.	6	10.6	b 7 c.
	18.	6	10.6	b 7 c.
	24.	6	10.2	b 2 v: Clouds.
	28.	6	10.1	b 0–1 v.
	29.	6	10.0	v b.
	Dec. 5.	6	9.7	a 8 b, v 3 b. Alt. 15.°

Date.		Hour.	Mag.	Observation.
1891.	Dec. 10.	6	9.5	a 7 b, v 4 b. Low moon.
	12.	6	9.3	a 5 b.
	17.	6	9.1	a 5–7 v. Alt. 15.° Daylight.
1892.	Apr. 6.	16	13.3	d 6 f.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.			
	°			s	′	
a	—19, 5403	9.1	*8.5*	+64	+ 1.0	M, 1890, Oct. 8, O—C=+32d. E=33.
b	5397	9.8	10.0	+29	— 1.7	Observations indicate a period of 219.5 days.
c	....	...	10.9	+21	— 0.5	C. P. 239 days.
d	....	...	*12.5*	— 7	+ 0.4	Epoch 1890, Oct. 8, with period 219.5d, gives M 1891, Dec. 16, so that the observation of 1891, Dec. 17, is probably right at M.
e	....	...	12.9	+19	+ 0.9	
f	....	...	*13.8*	0	+ 2.0	

7045. R Cygni.

R. A. = $19^{h}\ 32^{m}\ 56^{s}$. Decl. = + $49^{\circ}\ 52'.5$.

Date.			Hour.	Mag.	Observation.
1890.	Oct.	14.	11	8.7	v 10 b. Seeing poor.
	Nov.	4.	11	8.4	a 4 b.
		10.	12	7.9	a 2 b.
		18.	11	7.8	a 2 b. a 2—3 v.
		20.	10	7.8	a 2 b, a 2 v.
		23.	11	7.9	a 4 v.
		27.	10	8.1	a 3 b, a 5 v.
	Dec.	6.	9	8.2	a 3 b, a 5—6 v.
		10.	8	8.3	a 3—4 b, a 6—7 v, v very red.
		14.	8	8.4	a 4 b.
		21.	8	8.2	a 3 b: Seeing poor.
		30.	7	8.4	a 4 b. Seeing poor.
1891.	Jan.	2.	7	8.4	a 4 b.
		13.	7	8.4	a 4 b.
	Feb.	3.	9	8.4	a 4 b.
	Apr.	15.	16	9.5	v 2 b.
	Sept.	13.	13	13.0	v f. v est. 13—13.5.
		19.	12	....	v and f very ft. Bright moon.
		23.	14	13.0	v f: Bright moon.
	Oct.	2.	10	12.6	v 4 f.
		9.	11	12.5	v 5 f:
		15.	10	11.7	e 2—3 f:
		19.	10	11.5	e 2 v.
		23.	13	11.4	e 0—1 v. v est. 11.3.
		28.	10	11.2	c 5 e.
	Nov.	2.	9	11.1	c 0—1 v, d 0—1 v.
		10.	11	11.0	v d.

Date.			Hour.	Mag.	Observation.
1891.	Nov.	17.	11	10.6	b 7 c, v 6 c.
		28.	8	10.3	b 5 c, v just vis in finder.
		30.	10	10.3	b 5 d.
	Dec.	4.	8	10.1	b 3—4 d: v est. 10.0.
		10.	8	9.8	b 1 c, b 2 v, v reddish.
		15.	7	9.7	b 0—1 v.
		23.	8	9.1	a 7 b, v 5 b.
		26.	7	9.1	v 5 b, v red.
		29.	7	8.6	a 5 b.
1892.	Jan.	6.	7	8.3	a 8 v, v 15 b.
		9.	7	8.9	a 2 b, a 5 v.
		14.	7	7.9	a 2 b, a 4 v.
		20.	7	7.8	a 3 v. Seeing poor.
		21.	7	7.7	a 2 v.
		24.	7	7.6	a 1—2 v.
		26.	7	7.6	a 1 v.
		28.	7	7.5	v 0—1 a. Difference in color makes
	Feb.	5.	7	7.5	v a. [comparison difficult.
		9.	7	7.4	v 1 a.
		15.	7	7.4	v 0—1 a.
		25.	7	7.4	v 0—1 a. Low.
	Mar.	8.	7	7.5	v 0—1 a. Alt. 10°. Seeing bad.
		23.	12	7.8	a 3 v, a 2 b.
	Apr.	6.	15	7.9	a 4—5 v, a 2 b.
		15.	10	7.9	a 4 v, a 2 b.
		22.	13	8.2	a 6 v, a 3 b.
	May	15.	12	8.9	v 7—8 b, a 6 b.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.	Remarks.
a	+49°. 3059	7.0	7.5	-53^s $+2.2'$	M, 1890, Nov. 17, O—C= -16.6^d. E=8.
b	3065	9.0	9.7	$+2$ $+1.6$	M, 1892, Feb. 17, O—C= $+14.7^d$. E=9.
c	....	....	11.9	-9 -2.3	Interval 457^d.
d	....	....	11.0	-2 -3.0	C. P. 425.7.
e	....	....	11.3	-3 -2.2	First M rather sharp.
f	....	....	13.0	-4 -0.9	Second M very flat.
					Second M 0.4^m br. than first M.

7220. S Cygni.

R. A. = $20^{h}\ 2^{m}\ 28^{s}$. Decl. = $+\ 57^{\circ}\ 34'.2$.

Date.	Hour.	Mag.	Observation.
1890. Nov. 18.	11	<14.4	(v). Seeing rather poor.
Dec. 6.	9	13.1	e 5 f:: v est. 13.
10.	8	12.9	e 4 f.
14.	8	12.1	v e, v est. 12.5–13.0.
21.	8	12.0	v o–1 e: Bright moon.
1891. Jan. 2.	8	11.5	c 7 e.
13.	8	10.8	c 3 e, v est. 11.2. Seeing poor.
Feb. 3.	7	10.0	b 8 c, v 2 c, v est. 10.3.
10.	8	9.7	b 6 c.
21.	8	9.6	b 3 v.
26.	8	9.2	v 1–2 b.
Mar. 9.	8	9.5	b 3 v, b 2 c. Seeing poor.
18.	8	10.2	v c.
Apr. 9.	16	9.7	b 4 c.
15.	16	9.8	b 6 c. Fog.
Sept. 12.	14	<14.5	(v).
19.	12	<13.0	(v). Bright moon.
23.	14	<13.0	(v). Bright moon.
29.	16	<14.5	(v).
Oct. 2.	11	<14.5	(v).
4.	11	<14.5	(v).
9.	11	<14.5	(v). Seeing excellent.
15.	10	<13.0	(v). Bright moon.
19.	10	<13.0	(v). Bright moon.
23.	10	<14.5	(v).
28.	8	<14.0	(v). Little hazy.

Date.			Hour.	Mag.	Observation.
1891.	Nov.	2.	9	14.5	v. est. 14.5.
		10.	11	12.1	v e.
		17.	11	11.8	v 8 e.
		28.	8	11.6	v 5 e.
		30.	10	11.3	v 7 e, v d.
	Dec.	4.	9	11.3	v 9 e, v d.
		10.	8	11.0	c 7 d,
		15.	8	10.8	c 5 d.
		23.	8	10.5	c 8 d.
		26.	8	10.5	c 8 d.
		29.	8	10.3	c 0–1 v.
1892.	Jan.	6.	7	10.0	b 8 c, v 1–2 c.
		9.	8	9.9	b 7 c, v 3 c.
		14.	7	9.8	b 6 c.
		20.	7	10.1	v 0–1 c, b 7 v. Verified.
		21.	7	10.0	b 8 c.
		24.	7	9.9	b 7 c.
		26.	7	9.8	b 5 c.
		28.	7	9.8	b 5 c.
	Feb.	5.	7	9.6	b 3 c.
		9.	7	9.7	b 4 c.
		15.	7	9.7	b 4 c, b 4 v.
		25.	7	10.1	b 3–4 d, c 1 v, b 7 v.
	Mar.	8.	7	10.6	c 4 d, c 4–5 v.
		20.	7	11.1	v 2 d, c 10 v. Low,
		23.	11	11.4	d 0–1 v, v 7 e.
	Apr.	6.	15	12.1	v e, d 8 v.
		15.	10	13.5	e 7 f.
		22.	13	14.1	v f, v est. 14.2.
		27.	13	14.5	v just vis.
	May	15.	11	<14.5	(v).
		20.	14	<14.5	(v).

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.	Remarks.
a	+57°, 2185	8.9	8.9	+ 1ˢ + 1.0′	M, 1891, Feb. 28, O—C=+21.2ᵈ, E=29.
b	2180	9.8	9.8	—25 — 2.5	M, 1891, Apr. 5, O—C=+57.2, E=29.
c	.. ..	....	10.2	+18 — 1.7	M, 1892, Jan. 14, O—C=+19.0, E=30.
d	....	....	11.8	— 2 — 2.9	M, 1892, Feb. 8, O—C=+44.0, E=30.
e	....	....	12.1	— 9 + 0.8	Intervals 320ᵈ, 309ᵈ.
f	... .	....	14.1	+15 + 1.0	C. P. 322.2.
					Very positive evidence of a double maximum.
					Observations seem to show that comparison star e is too bright by about 0.4ᵐ.

7252. W. Capricorni.

R. A. = $20^h\ 5^m\ 57^s$. Decl. = $-22°\ 24'.9$.

Date.			Hour.	Mag.	Observation.
1890.	July	12.	11	<14.7	(v).
		23.	14	14.5	v very ft.
	Aug.	8.	12	11.5	v c.
		10.	12	11.5	v c.
	Sept.	9.	10	10.5	b o–1 v, a 11 v. Seeing poor.
		21.	11	10.2	a 8 b. Seeing poor.
	Oct.	14.	8	....	b 3 c, b 10 v, v est. 11.5 or 12.
	Nov.	4.	7	12.7	d 5 e. Seeing poor.
		10.	8	....	e—v. Alt. 20°.
		12.	7	13.4	e 5 v.
		19.	7	<12.5	(v). Bright moon.
		28.	7	<12.5	(v). Low.
1891.	Sept.	12.	8	<13.5	(v). Half moon.
		19.	8	14.7	v, vis. by glimpses.
	Oct.	15.	8	12.5	v d::
		27.	7	10.8	b 4 c.
	Nov.	2.	7	10.6	b 2 c, b 3 v.
		10.	7	10.5	b 1 c, b 1—2 v.
		17.	7	10.6	b 2 c, b 2 v.
		28.	6	10.8	b 4 c.
		29.	6	11.3	b 8 c.
	Dec.	5.	6	11.4	b 8—9 c. Clouds.
		10.	6	11.8	c 3 v.
		17.	6	....	d—v. Low.
1892	Apr.	9.	16	<13.	(v). e vis. by glimpses. Moon. Daylight

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
	°			s	′	
a	—22, 5374	9.4	*9.3*	+ 5	—4.0	M, 1890, Sept. 21, O — C = — 28d. E = 32.
b	....	....	*10.4*	+20	—0.8	M, 1891, Nov. 10, O — C = —31d. E=34.
c	....	....	11.5	+ 8	—0.3	Interval 207d 5.
d	....	....	12.5	+ 5	—2.1	C. P. 209.
e	....	....	12.9	+ 4	+1.3	Possibly period is twice too large.
f	....	....	*14.4*	0	—1.5	

7455. U. Capricorni.

R. A. = $20^h\ 40^m\ 4^s.$ Decl. = $-15^\circ\ 18'.8.$

Date.			Hour.	Mag.	Observation.
1890.	Nov.	4.	7	11.1	b 8 c, v 4 d.
		10.	8	10.6	b 3 c. Seeing rather poor.
		19.	7	10.3	b o—1 v.
		23.	8	10.1	a 6—7 b, v 2—3 b.
		27.	8	9.9	a 5 b.
		28.	8	9.9	a 5 b.
	Dec.	7.	8	9.9	a 4 b. a 4 v.
		10.	7	9.8	a 3 b: Seeing poor.
		14.	7	10.0	a 6 b, v very ft. in finder.
		21.	6	10.2	a 8 b, v 1 b. Seeing poor.
1891.	Jan.	4.	7	....	b—v. Low.
	Nov.	28.	8	12.6	d 10 v: Low.
		30.	6	12.7	e 3 v.
	Dec.	5.	6	12.1	c 7 e. Moon close.
		10.	6	11.3	v c.
		11.	6	11.4	c 5 d.
		17.	6	11.1	b 6 d.
		18.	6	11.1	b 6 d.
		23.	6	10.6	b 3 c.
		26.	6	10.6	b 3 v.
		27.	6	10.5	b 2—3 v.
		29.	6	10.5	b 2 v.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
a	−15°, 5797	9.6	*9.6*	$+34^s$	$-1.5'$	M, 1890, Dec. 5, O − C = − 64.5^d E=83.
b	....	....	*10.3*	+35	−6.7	Small oblong nebula follows variable 8^s, $3.5'$ to the south.
c	....	....	*11.3*	− 1	−4.9	
d	....	....	*11.6*	+18	−3.7	
e	....	....	*12.4*	+ 3	−4.0	

7577. X Capricorni.

R. A. = $21^h\ 0^m\ 15^s$. Decl. = — $21°\ 55'.8$.

Date.		Hour.	Mag.	Observation.
1890.	Sept. 22.	10	13.7	v very ft. Nearly 14.
	Oct. 18.	10	12.2	v f:
	Nov. 4.	8	10.5	d 2 v.
	10.	9	10.0	a 3 d. Seeing poor.
	19.	7	9.8	v b, v 3 a.
	23.	7	9.8	v 1–2 b.
	27.	7	9.6	v 4 b.
	Dec. 7.	7	9.7	v 3 b. Alt. 20°.
	14.	7	9.5	v 4–5 b.
	21.	7	9.5	v 5 b.
1891.	Jan. 4.	7	9.5	v 5-6 b: Low.
	Sept. 21.	7	...	f 10 v::
	Oct. 22.	7	<13.5	(v). Light clouds.
	23.	8	<14.0	(v). Little hazy.
	25.	8	<14.7	(v).
	27.	7	<14.3	(v). Light clouds.
	28.	7	<16.2	(v). Stone. 26-inch. Leander McCormick Obsy.
	Nov. 2.	7	<14.7	(v).
	10.	7	<13.5	(v). Bright moon.
	17.	7	<13.0	(v). Bright moon.
	18.	7	<14.5	(v).
	28.	7	14.5	v very ft. Alt. 15°.
	29.	7	14.5	v extremely ft.
	30.	6	14.3	v very ft. v not br. 14^m.
	Dec. 10.	6	<12.2	(v), f very ft. Bright moon.
	17.	6	12.0	a 9 f, v 2 f.

Date.		Hour.	Mag.	Observation.
1891.	Dec. 23.	6	11.2	d 5 e.
	29.	6	11.2	d 5 e.
1892.	Apr. 9.	16	<12.	(v), (g), (f). (e). Moon. Daylight.

COMPARISON STARS.

*	B. D.	Mag.		Co-ordinates.		Remarks.
		B. D.	T.	s	′	
a	....	....	9.9*	+ 9	−3.3	m about 1891, Nov. 5.
b	....	....	10.0	+30	−2.2	Invisible for over a month.
c	....	....	10.1	−20	−1.3	
d	....	....	10.3	+12	−3.5	m below 16.m2 — See observation 1891, Oct. 28.
e	....	....	12.0	+13	−2.0	
f	....	....	12.2	− 2	−0.5	
g	....	....	12.6	+11	−2.9	*Each comparison star mean of three observations.

7659. T Capricorni.

R. A. = $21^h\ 14^m\ 0^s$ Decl. = $-15^\circ\ 46'.4$

Date.			Hour.	Mag.	Observation.
1890.	Sept.	9.	12	12.6	e 3 v: Seeing poor.
		22.	10	12.9	e 6–8 v:
	Oct.	14.	8	13.3	e 10 v:
		18.	10	13.5	e 10 v, v est. 14.
	Nov.	4.	8	13.5	v est. 13.5. Seeing very poor.
		10.	9	13.0	v est. 13.5, d 10 v.
		11.	9	13.0	v est. 13.5, d 10 v.
		12.	8	12.8	e 5 v.
		23.	8	<12.3	e–v.
1891.	Sept.	19.	10	....	e–v.
		22.	9	12.5	e 2–3 v.
	Nov.	28.	8	8.8	v 1 b, v est. 8.4.
		29.	8	8.8	v 1 b, a 6 v.
	Dec.	5.	6	8.9	v b.
		15.	7	9.1	b 2 c, b 2 v.
		23.	6	9.7	b 3 c, v 3 c.
		26.	6	9.7	v 2 c, b 6–7 v.
		29.	6	9.8	v 2 c, b 8 v.
1892.	Jan.	2.	6	10.2	c 2 v.
		8.	6	10.3	c 3–4 v.

COMPARISON STARS.

*	B. D.	Mag. B. D.	Mag. T.	Co-ordinates.		Remarks.
a	-15°, 5958	8.0	*8.1*	-30^s	$+0'.8$	m, 1890, Oct. 22.
b	5959	9.0	*8.9*	-3	$+4.3$	M, 1891, Nov 29, O—C= —12.8d . E=34.
c	5964	10.	*10.0*	$+31$	0.0	M, somewnat uncertain.
d	....	...	*11.8*	-11	$+1.2$	
e	...	...	*12.3*	$+10$	-2.0	

100. T Ceti.

R. A.= $0^h\ 14^m\ 26^s.$ Decl.= $-20^\circ\ 51'.8.$

Date.		Hour.	Mag.	Observation.
1889.	Dec. 12.	9	....	v 0-2 b, v-c, a-v.
	Dec. 22.	8	....	v-b, v-d, a-v.
				a=B D—19°, 21. d=B D—21°, 57.
				c=B D—20°, 67. d=B D—19°, 30.

715. S Arietis.

R. A.= $1^h\ 56^m\ 51^s.$ Decl.= $+11^\circ\ 49'.7.$

Date.		Hour.	Mag.	Observation.
1890.	Jan. 8.	9	....	v about 14. Possibly not the v.
	Oct. 20.	7	....	v about 13.

806. *o* Ceti.

R. A. = 2h 12m 1s. Decl. = − 8° 38′.3.

Several observations were obtained of this star between 1891, Nov. 28, and 1892, March 8. The variable was nearly constant in brightness for most of this period, but the observations are not of sufficient accuracy to determine a minimum. The variable was compared with B. D.,—3°, 355, but at no time during the observations was it estimated less than 0.4 brighter than B. D.,— 3°, 355. From 1892, Jan. 26, to 1892, March 8, there was a sensible though small increase of brightness.

845. R. Ceti.

R. A. = 2h 18m 38s. Decl. = — 0° 50′.1.

Date.		Hour.	Mag.	Observation.
1889.	Dec. 26.	12	....	c o—2 v, v 2—3 f.
1890.	Jan. 8.	10	....	a 7 c.
	23.	10	....	c 1 v, a 4 v.
	Feb. 8.	10	....	c 4 b, v e.
				a=B. D.,—1°, 338. b=B. D.,—1°, 339.
				c=B. D.,—0°, 367. e=B. D.,—1°, 333.
				f=B. D.,—0°, 365.
				M, 1890, Jan. 12. O—C=—5.6d. E=42.

2100. U Orionis.

R. A. = 5h 47m 13s. Decl. = +20° 8′.7.

Date.		Hour.	Mag.	Observation.
1891.	Sept. 29.	17	....	v 3 a. a = B. D., + 20° 1169.

2780. T Geminorum.

R. A. = $7^h\ 40^m\ 36^s.$ Decl. = $+24^\circ\ 5'.5.$

Date.	Hour.	Mag.	Observation.
1889. Dec. 30.	16	....	va. a = B. D., + 23°, 1818.

2857. U Puppis.

R. A. = $7^h\ 54^m\ 2^s.$ Decl. = $-12^\circ\ 26'.6.$

Date.	Hour.	Mag.	Observation.
1889. Dec. 30.	13	....	a 5 b. a = Chandler's first identification star. b=Chandler's second identification star A. J. No. 183.

5688. R Librae.

R. A. = $15^h\ 45^m\ 24^s.$ Decl. = $-15^\circ\ 48'.1.$

Date.	Hour.	Mag.	Observation.
1890. July 15.	10	....	v est. 13 or 13.5.

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Born 1818; Died 1882.

INTRODUCTION.

The following pages are designed to present in some detail the data available for a determination of the latitude of the Washburn Observatory with special reference to possible variations in that latitude. For this purpose I have discussed both absolute determinations of latitude and those secondary determinations which rest upon assumed declinations of certain stars. In the latter case the system of declinations prepared by Auwers for the zone observations of the Astronomische Gesellschaft has been employed without exception, but in some cases which are specially noted, corrections have been applied to the declinations of the *Berliner Jahrbuch* to reduce them to the system of the *Vorläufiger Fundamental-Katalog für die Südlichen Zonen.* Whenever these corrections are not specified it is to be understood that the positions furnished by the *Berliner Jahrbuch* have been employed without change.

I have not found it convenient to follow a chronological order in the discussion of the various latitude determinations but shall consider first the absolute latitudes.

CHAPTER I.

ABSOLUTE LATITUDES.

Observations made with the Repsold meridian circle between 1883 and 1890 furnish data for two determinations of absolute latitude and of these it will be convenient to treat the second and more complete determination first.

This determination was made in the years 1888–'90 by Prof. S. J. Brown, U. S. N., assisted by Mr. H. V. Egbert and Mr. A. S. Flint. Two observers usually took part in the observations, one at the telescope and one at the microscopes, but the observation is always designated as made by the observer at the telescope. During Mr. Egbert's connection with the work, 1888–'89, he and Prof. Brown observed on alternate nights at the telescope, but subsequent to his departure, Sept. 1, 1889, all observations at the telescope which have been used in this discussion were made by Prof. Brown.

A general description of the meridian circle together with an investigation of its constants will be found in earlier volumes of the Publications of this observatory, but since the date of those investigations the instrument has been made the subject of further study and it seems advisable to publish here a *résumé* of the data upon which the adopted values of the instrumental constants depend.

FLEXURE.—The flexure constants of the instrument have been investigated by three different methods and the results of one of these are given in Publications W. O., Vol. V., p. 27, but to the data there given there should be added one determination Circle West, by Prof. Brown, in 1887, Oct.—Dec. From observations on seven days he found $h = +0.''19$.

The second method employed for the determination of flexure, the use of leveled collimators in connection with observations of the nadir, is so familiar as to require no description beyond the statement that in connection with the readings of the spirit level the collimators were turned end for end in their wyes so that the inequality of pivots is eliminated from the adopted inclinations of the axis of the pivots.

In the third method of investigation the collimators were replaced by a floating mirror supported as follows: Upon the collimator pier is placed a shallow rectangular iron basin 48 x 28 *cm.* in size, attached to, and free to revolve about, a vertical axis which is carried by a tripod with leveling screws resting upon the head of the pier. This basin is partially filled with mercury upon which floats a light wooden platform 43 x 24 *cm.*, to which are attached trunnions fitting neatly into grooves at the middle of the long side of the basin. These trunnions preclude all save a very minute lateral motion of the platform but allow it to rotate freely about the horizontal line defined by their axes, and

to assume a position of equilibrium. The platform carries a circular mirror 127 *mm.* in diameter supported upon a horizontal axis coinciding with one of its diameters, and is free to revolve about this axis, so that by combining this motion with a rotation of the basin about the vertical axis upon which it is supported the normal to the mirror may be brought into any desired position. Suitable clamps and slow motion screws are provided for this purpose. The mirror, made by Mr. J. A. Brashear, is of plate glass 14 *mm.* thick and silvered on both faces, both of which Mr. Brashear cousidered to be sensibly plane surfaces at the time the apparatus left his hands, but which have been designated by the letters G. and B., good and bad, from the quality of the images which they furnish when a high magnifiying power is employed. The eye-piece commonly employed furnished a magnifying power of 68 diameters and the excellence of the mirror is sufficiently shown by the fact that satisfactory observation of the reflected image of the micrometer threads was possible.

The method of using the apparatus for determining the horizonal point is as follows: The telescope of the meridian circle is set so that the zenith distance of the line of sight is approximately 90°, and the mirror so adjusted in position that the normal to one of its reflecting surfaces, G., is parallel to the line of sight of the telescope. By means of a collimating eye-piece an image of the threads of the meridian circle may now be seen reflected from the mirror precisely as in observations of the nadir, and if the face of the mirror could be assumed to be vertical the required circle reading corresponding to the horizon could be immediately obtained. In general, however, this will not be the case and it will be necessary to revolve the basin about the vertical axis and to make a similar observation by reflection from the face B. The mean of these results is independent of the adjustment of the mirror, but involves whatever error may arise from a failure of the floating platform to return to the same position with respect to the vertical that it occupied in the first observation, and is also dependent upon the assumed perfect parallelism of the faces of the mirror. This latter source of error is immediately eliminated by revolving the mirror 180° about its horizontal axis and repeating the observations in this position. From numerous observations of this kind the angle included between faces B and G was found to be 0.″3. The two positions of the mirror in which its faces are approximately vertical are distinguished with reference to the position of a certain screw in its mounting, as Screw Up, and Screw Down, and a complete observation of the horizontal point consists of readings of the circle and telescope micrometer in the four positions represented by the letters GU., BU., GD., BD., but no such determination is considered satisfactory unless it is accompanied by additional observation, GU. and BU. agreeing with the first ones within the limits of their probable accidental errors, thus assuring the stability of the apparatus itself during the progress of the observations. It will be seen that the principle involved is that of Chandler's Almucantar, and that the apparatus does not differ essentially from that described by

Schaeberle, *Astr. Nachr. Bd. 118., Col. 147.* Experience has shown that by the exercise of great care and patience results of a high degree of precision may be obtained with this apparatus, but it has proved an exceedingly laborious method since in at least one-half of all the cases the control observations GU. and BU. fail to agree with the initial ones and the set must be discarded.

In Publications W. O. Vol. II p. 83 the horizontal flexure of the meridian circle is represented by h and its relations to the circle readings as there defined is such that the flexure correction to circle readings will have opposite signs for the two positions of the circle. Adopting this convention and representing the coefficient of the cosine flexure by k we obtain for any given circle reading, R, the following corrections.

$$\textit{Circle W.}\quad \triangle R = +\, h \sin z + k \cos z$$
$$\textit{Circle E.}\quad \triangle R = -\, h \sin z + k \cos z$$

where $z = \varphi - \delta$. As special cases of these formulae we have for determinations of the nadir and horizon points.

	Circle W.	Circle E.
Corrected North Horizon..........	$R_1 - h$	$R' + h$
Corrected Nadir......	$R_2 - k$	$R'' - k$
Corrected South Horizon	$R_3 + h$	$R''' - h$

from which there results for the angular distance between these points

$$\text{N. Horizon} - \text{Nadir} = 90^\circ + h - k \quad or \quad 90^\circ + h + k$$
$$\text{S. Horizon} - \text{Nadir} = 90 \ + h + k \quad or \quad 90 \ + h - k$$

by means of which values of h and k have been derived from the measured angles between the horizon points and nadir. A correction of 0.″08 has been applied to the measured angles to take into account the difference in the direction of gravity at the nadir basin and at the collimator piers.

The following summary of results includes all of the satisfactory determinations that have been made by the various methods since the instrument was mounted:

Mean results from the Floating Mirror

Circle W.	Circle E.
North Angle....$h - k = +\ 0.''10$	North Angle.. .$h + k = +\ 0.''32.$
South Angle....$h + k = +\ 0.\ 65$	South Angle....$h - k = +\ 0.\ 28.$
$h = +\ 0.''38$ $\quad k = +\ 0.''28$	$h = +\ 0.''30$ $\quad k = +\ 0.''02.$

From Leveled Collimators:

Circle W.	Circle E.
North Angle $h - k = +\ 0''.28$	North Angle $h + k = +\ 0''.84$
South Angle $h + k = -\ 0\ .05$	South Angle $h - k = +\ 0\ .45$
$h = +\ 0''.12$ $\quad k = -\ 0''.16$	$h = +\ 0''.64$ $\quad k = +\ 0''.19$

From Opposing Collimators:

Circle W. $h = +0''.11$ Circle E. $h = +0''.88$

From Observations of Zenith Stars Circle W and Circle E:

$k = +0''.06.$

I know no reason for supposing that h and k have different values in the different positions of the circle, and I have therefore united the several results into a mean by the weights assigned in the following table:

VALUES OF THE FLEXURE COEFFICIENTS.

Determination.	h.	Weight.	k.	Weight.	Adopted.
Mirror, Circle W	+0''.88	2	+0''.28	2	
Mirror, Circle E............	+ .80	2	+ .02	2	
Leveled Coll., Circle W.....	+ .12	1	− .16	1	$h = +0''.88.$
Leveled Coll., Circle E......	+ .64	2	+ .19	2	$k = +0''.09.$
Opposed Coll., Circle W.....	+ .11	2	....	..	
Opposed Coll., Circle E	+ .88	7	....	..	
Zenith Stars, Circle W. & E.	....	..	+ .06	5	

The adopted values of h and k given above have been used in the reduction of all the observations for the determination of the absolute latitude, but I am not entirely satisfied with these values and consider them to require further investigation.

The construction of the meridian room is such that very serious obstacles stand in the way of reflection observations. I have attempted to overcome these by providing a device for supporting the mercury basin from the collimator piers and a considerable number of reflection observations of northern stars were made by Prof. Brown and Mr. Flint with a view of determining the flexure constants by this method. The results are, however, so discordant, both with the other determinations and *inter se*, that I do not consider them as entitled to any weight whatever and they are therefore omitted from the summary. Prof. Brown's observations give a sine flexure of $+0.''06$ and Mr. Flint's, $-0.''80$.

Division Errors.—The division errors of the circle have been made the subject of prolonged investigation by Prof. Brown, Mr. Egbert and Mr. Flint. The details of this investigation will be reserved for another volume, but it may be stated here that the error of *each ten minute diameter* has been determined by Kaiser's method (*Leiden Annalen, Bd. II*); that these errors have been platted and a curve drawn through them from which there has been constructed a

table giving for each degree of declination the correction to be applied to the observed declination of the star. The curve is sufficiently smooth to allow of linear interpolation within a space of a degree without error exceeding the probable error of the corrections themselves. An inspection of the course of this curve among the plotted points shows that the average residual obtained by comparing all of these points with the curve is not far from 0.″1, *i. e.* the probable error of an observed division correction is presumably not greater than this quantity and the probable error of a correction read from the curve is presumably less than this quantity.

It should be noted in this connection that at the beginning of Prof. Brown's work the meridian circle was so adjusted that the same divisions come under the microscopes in observing the nadir in both positions of the circle, thus obviating the necessity for a special investigation of the errors of these lines as this error will be eliminated from the mean of observations, Circle W. and Circle E.

SYSTEMATIC PERSONAL ERROR OF THE OBSERVERS. — As a partial control upon the personal errors with which his observations might be affected, Prof. Brown observed a considerable number of stars culminating near the zenith, both as north and south stars. Unfortunately no such observations were made by Mr. Egbert, and Prof. Brown's observations are limited to the Circle E. position of the instrument. From 32 stars observed 74 times with the observer's feet toward the north, and 76 times with feet south, I find for the difference of $\Delta\delta$.

Obs'r B. N.—S. = +0.″07 ±0.″064 Circle E.

and in the absence of data I assume the same value for Circle W. The corresponding quantities for observer E. must be determined from the systematic differences B. — E., the values of which, derived from a discussion of all the cases in which a star was observed three or more times in each position of the circle by each observer, are given in the following table:

SYSTEMATIC DIFFERENCE, B.—E., OF THE OBSERVED DECLINATIONS.

DATA.	CIRCLE W. B. — E., $\Delta\delta$		**	CIRCLE E. B. — E., $\Delta\delta$		**
	″	″		″	″	
Stars below pole........	+0.10	±0.03	90	+0.25	±0.04	48
Stars between pole and zenith...	+0.07	±0.03	96	+0.20	±0.04	51
Stars south of zenith...........	−0.18	±0.03	89	+0.10	±0.04	51

These numbers diminish from north to south but the variation is not sufficiently marked to establish a real dependence of the quantities upon the decli-

nation of the stars, except a probable abrupt change at the zenith. An examination of the residuals furnished by the several stars indicates that the probable accidental error of an observation by B. is rather less than for E. but in the absence of any further information in regard to the systematic errors of the two observers it appears proper to adopt the mean of their results as a normal system. The individual $\Delta\delta$s are reduced to this system by the application of the following corrections derived from the values of B—E. given above:

Stars.	Circle W.		Circle E.	
	B.	E.	B.	E.
North.	$-0''.04$	$+0''.04$	$-0''.11$	$+0''.11$
South.	$+0.09$	-0.09	-0.05	$+0.05$

In the construction of this table no use has been made of the determination of the systematic difference N.—S., Circle E. by B., but it will be observed that the difference of the corrections to B's observing, Circle E. is in complete agreement with the observed difference between stars on opposite sides of the zenith and this difference is therefore fully taken into account.

The methods employed in the reduction of the observations are those in common use and seem to require no extended explanation. It should, however, be explicitly stated that the zenith point reading of the circle has been derived solely from observations of the nadir and that in the discussion of the latitude no observations are included which were not both preceded and followed by an observation of the nadir. The average interval of time between the nadir determinations is not far from 2.2 hours, and within this period the variation of the nadir is usually assumed to be proportional to the time, but for a few nights in which several nadirs were observed they have been plotted and the instantaneous value of the nadir reading derived from a curve drawn through the plotted points. For all observations made when the circle was west the observer stood north of the telescope in making the nadir observation, and for observations made with the circle east the observer stood south of the telescope in observing the nadir. No determination of the systematic difference arising from the changed position of the observer was made by either Prof. Brown or Mr. Egbert, but such determinations made in previous years by three different observers indicate no such difference of sensible magnitude. Should such a difference exist it ought to be nearly if not quite eliminated from the mean of observations Circle W. and Circle E.

The refractions have been computed from the Pulkowa tables uncorrected for the difference of gravity at Pulkowa and Madison.

The observed apparent places of the stars have been compared with the apparent places given by the *Berliner Jahrbuch* and the result of each declination observation is stated as a correction to the ephemeris value. It should be especially noted that in the case of stars observed below pole the declinations are reckoned through the pole and the resulting $\Delta\delta$ is the correction to the supplement of the tabular declination.

The following table exhibits the result derived from each star observed ten or more times both above and below pole, but a few stars remote from the pole have been included, although their number of observations falls somewhat below the prescribed limit. All of the observations were reduced with an assumed latitude of 43° 4′ 37″.00, and the resulting $\Delta\varphi$ is to be applied as a correction to this quantity. The weight p assigned to the result from each star has been derived as follows:

The error of a single observed zenith distance is composed of two parts, one variable from night to night, the other constant so long as the instrument is used under similar conditions. I have shown (*A. J., Vol. VIII, p. 158*) from a consideration of earlier observations with this instrument that the former class of errors are fairly represented by the empirical formula for the probable error of a single observation,

$$\pm r_1, = + 0.''34 + 0.''07 \tan z.$$

in which the zenith distance z is to be consided always positive. The second class of errors is due to undetermined division corrections, erroneous values of the flexure constants, etc., but it should be noted that if the results of observations Circle W. and Circle E. be combined with equal weights the division errors of the nadir lines and the cosine flexure terms are eliminated. I therefore adopt for the second kind or errors,

$$r_2 = \sqrt{\tfrac{1}{4}g^2 + h^2 \sin^2 z}$$

in which g represents the probable error of an interpolated division correction for a single diameter of the circle and h is the probable error of the coefficient of the sine flexure term. I estimate the numerical values of these quantities to be respectively ±0.″10 and ±0.″04.

The complete expression for the probable error of a declination derived from n observations equally distributed between Circle W. and Circle E. is therefore

$$r^2 = \frac{r_1^2}{n} + \frac{g^2}{4} + h^2 \sin^2 z$$

and the probable error of the sum or difference of two declinations

$$\rho^2 = \frac{(r_1')^2}{n'} + \frac{(r_1'')^2}{n''} + \frac{g^2}{2} + h^2 (\sin^2 z' + \sin^2 z'',$$

and the weight to be assigned to a latitude determination made by combining observations above and below pole is proportional to the reciprocal of this quantity. For this particular case $z' = 90° - \varphi - P$ and $z'' = 90° - \varphi + P$ and the variable terms in the expression may be tabulated with the polar distance, P, as argument. For the sake of simplicity I have assumed $\nu' = \nu'' =$ the smaller of the two numbers and have put

$$(r_1')^2 + (r_1'')^2 = 0.03\,\mu \qquad \frac{g^2}{2} + h^2 (\sin^2 z' + \sin^2 z'') = 0.03\,\nu$$

$$\text{Weight} = p = \frac{10\,n}{\mu + \nu n}$$

and have tabulated μ and ν with the argument P as follows: In the actual applications of these weights I have however assumed that beyond 72° zenith distance they should diminish somewhat more rapidly than is represented by the formula and have therefore multiplied the tabular values of p by the factor

$$f = \frac{40 - P}{15}$$

in which P is expressed in degrees.

TABLE FOR WEIGHTS.

P.	μ		ν	P.	μ		ν
°							
0	11.5	0	0.22	16	12.5	3	0.22
2	11.5	1	.22	18	12.8	4	.22
4	11.6	0	.22	20	13.2	5	.22
6	11.6	1	.22	22	13.7	7	.22
8	11.7	1	.22	24	14.4	9	.22
10	11.8	2	.22	26	15.3	11	.22
12	12.0	2	.22	28	16.4	17	.22
14	12.2	3	.22	30	18.1	25	.22
16	12.5		.22	32	20.6		.22

$$p = \frac{10\,n}{\mu + \nu\,n} \qquad f = \frac{40 - P}{15} \quad \textit{for } P > 25°.$$

Each observed correction to the tabular declination of a star has been corrected for the effect of an assumed annual variation of the latitude represented by the term

$$+0''.26 \sin (L + 62^\circ).$$

where L is the sun's longitude.

I do not consider this the best representation of the periodic term which is now attainable, but in a general way it corresponds with the observed variations, and it will be subsequently shown that the mean latitude result is practically independent of the form of the periodic variation.

The following table contains the data furnished by every star, which is considered available for a latitude determination. Corrections to the tabular declinations derived from observations above and below pole, together with the number of observations included in the mean result are given in columns three to seven inclusive, while the final correction and the residual furnished by the adopted latitude are contained in the columns $\Delta\delta$ and v.

TABLE I.—INDIVIDUAL RESULTS FOR LATITUDE.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	″		″		″		″	″
λ Urs. Min	1.0	+0.73	37	−0.37	25	+0.36	15	0.10	+0.55
α Urs. Min	1.3	−0.01	43	+0.11	38	+0.10	19	.23	− .06
51 H. Cephei	2.8	+0.21	26	+0.33	19	+0.54	12	.01	− .06
δ Urs. Min	3.4	+0.52	25	+0.01	22	+0.53	14	.02	+ .26
43 H. Cephei	4.3	+0.15	15	+0.67	16	+0.82	11	.13	− .26
Gr. 750	4.8	+0.47	40	−0.19	34	+0.28	18	.14	+ .33
30 H. Camelop	6.9	+0.09	11	+0.48	13	+0.57	8	.00	− .20
ε Urs. Min	7.8	+0.51	25	+0.46	27	+0.97	14	.20	+ .02
76 Draco	7.9	+1.01	13	−0.23	15	+0.81	9	.12	+ .64
1 H. Draco	8.2	+0.35	27	+0.61	27	+0.96	15	.20	− .13
Br. 2749	9.8	+0.49	15	+0.29	13	+0.78	9	.11	+ .10
23 H. Camelop	10.3	+0.74	12	−0.26	11	+0.48	8	.04	+ .50
Gr. 2900	10.6	+0.76	13	−0.02	12	+0.74	8	.09	+ .39
19 H. Camelop	10.9	+0.23	12	+0.46	12	+0.69	8	.06	− .12
44 H. Cephei	10.9	+0.93	12	−0.17	12	+0.76	8	.10	+ .55
47 H. Cephei	11.0	−0.70	13	+0.26	10	−0.44	7	.50	− .48
Br. 1508	11.6	−0.02	12	+0.47	12	+0.45	8	.06	− .24
4 H. Draco	11.8	+0.03	18	+0.77	18	+0.80	11	.12	−0.37
4 Urs. Min	11.9	+0.28	13	+0.53	18	+0.81	9	.12	− .12
Br. 2777	12.3	+0.76	13	+0.30	12	+1.06	8	.25	+ .23
Gr. 2373	12.3	+0.12	12	+0.01	13	+0.13	8	.22	+ .06
Gr. 1852	12.5	+0.08	12	+0.35	12	+0.43	8	.06	− .14
Gr. 2655	12.5	+1.28	12	−0.97	12	+0.31	8	.12	+1.12
κ Cephei	12.6	+1.36	13	+0.01	12	+1.37	8	.40	+ .68
48 H. Cephei	12.7	+0.13	11	+0.35	12	+0.48	8	.04	− .11
24 H. Camelop	12.9	+0.42	14	+0.46	13	+0.88	9	.16	− .02
γ Cephei	13.0	+1.13	27	−0.42	23	+0.71	14	.08	+ .78
35 Draco	13.0	+0.81	14	−0.54	13	+0.27	9	.14	+ .68
Br. 6	13.7	+0.96	12	−0.27	12	+0.69	8	.06	+ .63

TABLE I.—INDIVIDUAL RESULTS FOR LATITUDE—Continued.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	″		″		″		″	″
9 H. Draco	13.7	+0.54	21	+0.22	25	+0.76	12	.10	+ .16
19 H. Urs. Min.	13.8	+0.41	12	+0.09	12	+0.50	8	.03	+ .16
Br. 1147	13.9	+0.22	12	+0.76	13	+0.98	8	.21	— .27
η Urs. Min	14.0	0.00	13	+0.26	12	+0.26	8	.15	— .13
Gr. 848	14.3	—0.24	13	+0.74	12	+0.50	8	.03	— .49
π Cephei	15.2	+0.80	12	+0 12	11	+0.92	7	.18	+ .34
73 Draco	15.4	+0.64	13	+0.12	12	+0.76	8	.10	+ .26
21 Cassiop	15.6	+0.16	12	—0.02	13	+0.14	8	.21	+ .09
Gr. 1374	15.8	—0.06	12	+0.64	13	+0.58	8	.01	— .35
Gr. 1446	16.0	—0.01	12	+0.40	13	+0.39	8	.08	— 20
Gr. 1586	16.6	0.00	11	+0.72	12	+0.72	7	.08	— .36
31 Cephei	16.8	+0.43	10	+0.43	12	+0.86	7	.15	00
Gr. 2001	17.0	+0.16	12	+0.26	13	+0.42	8	.07	— .05
40 Cassiop	17.5	+0.31	12	+0.83	12	+1.14	8	.29	— .26
ψ Draco. aust.	17.8	+0.66	13	+0.10	12	+0.76	8	.10	+ .28
Gr. 2029	18.2	—0.10	12	+0.05	13	—0.05	8	.30	— .08
24 Cephei	18.2	+0.50	12	+0.27	11	+0.77	7	.10	+ .12
φ Draco	18.7	+0.62	13	+0.03	12	+0.65	8	.04	+ .30
υ Draco	18.9	+0.91	12	—0.17	12	+0.74	8	.09	+ .37
5 H. Camelop	19.0	+0.13	12	—0.11	12	+0.02	8	.27	+ .01
11 Cephei	19.2	+0.87	13	+0.47	11	+1.34	7	.30	+ .20
d Urs. Maj	19.7	+0.40	13	+0.48	12	+0.88	8	.16	— .04
λ Draco	20.1	+0.08	10	—0.02	13	+0.06	6	.25	+ .05
Gr. 1564	20.3	+0.26	13	+0.81	12	+1.07	8	.26	— .28
35 Urs. Maj.	20.3	+0.49	12	—0.11	12	+0.38	8	.09	+ .30
22 H. Camelop	20.6	+0.09	14	+0.59	11	+0.68	7	.06	— .25
43 Camelop	21.0	—0.98	12	+1.35	12	+0.37	8	.10	—1.16
ω Draco	21.2	+1.04	12	—0.48	12	+0.56	8	.00	+.76
f Draco	21.8	+0.93	13	—0.14	13	+0.79	8	.10	+.54

TABLE I.—INDIVIDUAL RESULTS FOR LATITUDE—Continued.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	″		″		″		″	″
ρ Urs. Maj	21.9	+0.33	12	+0.37	13	+0.70	7	.07	—.02
1 H Urs. Maj	22.2	+0.28	12	—0.17	12	+0.11	7	.22	+.22
σ² Urs. Maj	22.4	—0.14	12	+0.65	12	+0.51	7	.02	+.40
ψ Cassiop.	22.4	+0.74	12	—0.38	12	+0.36	7	.10	+.56
43 Cassiop	22.5	+0.28	12	—0.01	12	+0.27	7	.14	+.14
3 Draco	22.6	—0.03	11	+0.21	12	+0.18	7	.19	+.12
Br. 366	22.6	+0.19	13	+0.04	12	+0.23	7	.16	+.08
41 H Cephei	22.8	+0.40	12	—0.07	12	+0.33	7	.12	+.24
2 H Urs. Maj	23.6	—0.52	12	+0.84	14	+0.32	7	.12	+.68
30 Urs. Maj	23.9	—0.21	11	+0.45	12	+0.24	7	.16	—.33
8 Draco	24.0	+0.51	12	—0.34	12	+0.17	7	.20	+.42
55 Cassiop	24.0	+0.61	13	+0.06	12	+0.67	7	.06	+.28
36 Camelop	24.3	+0.16	13	—0.10	10	+0.06	6	.25	+.13
Gr. 2640	24.6	+1.03	12	—0.25	10	+0.78	6	.11	+.64
ι Draco	24.7	+0.73	12	—0.20	13	+0.53	7	.02	+.46
Gr. 1771	25.1	+0.54	12	—0.08	12	+0.46	7	.05	+.31
36 Draco	25.6	+1.06	13	+0.26	12	+1.32	7	.38	+.40
Br. 82	26.3	+0.63	12	+0.20	13	+0.83	6	.14	+.22
76 Urs. Maj	26.7	+0.53	12	+0.32	12	+0.85	6	.14	+.10
30 Cephei	27.0	+1.21	12	—0.03	9	+1.18	4	.28	+.64
17 Camelop	27.0	+0.25	13	+0.63	13	+0.88	6	.16	—.19
12 H Draco	27.1	+0.17	12	+0.34	11	+0.51	5	.03	—.08
Gr. 716	27.1	—0.69	12	+0.72	12	+0.03	5	.26	—.70
20 Cephei	27.8	+0.46	12	+0.26	12	+0.72	5	.13	+.10
4 Cassiop	28.3	+1.01	12	—0.06	12	+0.95	5	.20	+.54
8 Lyncis	28.4	—0.66	11	+0.69	12	+0.03	5	.26	—.68
9 H Camelop	29.2	—0.51	13	+0.90	13	+0.39	4	.08	—.70
Gr. 2125	29.3	+1.13	12	—0.77	13	+0.36	4	.10	+.95
53 Camelop	29.4	+0.80	13	+0.86	13	+0.66	4	.05	—.03

TABLE I.—INDIVIDUAL RESULTS FOR LATITUDE—Continued.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
69 H Urs. Maj	29.5	+0.84	12	—0.47	12	+0.87	4	.10	+.66
Gr. 2164	30.3	—0.45	12	+0.50	14	+0.05	4	.26	—.48
2 H Camelop	30.4	—0.25	12	+0.41	10	+0.16	3	.20	—.33
74 Urs. Maj...	31.0	+0.27	12	—0.17	12	+0.10	3	.23	+.22

In the following table the results from the individual stars are united into groups, each group containing all the stars included within the zone whose limiting polar distances are given in the first column of the table. The columns headed Increment of Flexure, Refraction, Temperature, respectively show the effect which would be produced upon the latitude by increasing the coefficient of the sine flexure by 0."10; increasing the coefficient μ of the refraction tables by 0."10; increasing the adopted thermometer readings by 1°F.

TABLE II.

N. P. D.	No. of stars.	Weight.	φ'	INCREMENT OF		
				Flexure.	Refraction.	Temperature.
° °			"	"	"	"
1.0... 8.2	10	135	36.72	+0.07	—0.11	+0.13
9.8... 13.0	18	156	36.69	.07	.12	.14
13.7... 18.9	20	160	36.69	.07	.13	.15
19.0... 24.0	23	159	36.74	.07	.15	.18
24.3... 31.0	21	106	36.72	.07	.22	.26

From a discussion of the residuals v furnished by the first 45 stars of the above list, *i. e.*, all of the stars within 18° of the pole, I find as the probable error of an observation of unit weight $r = \pm 0.''340$. Similarly from the last 46 stars, all stars more than 18.°2 from the pole, I obtain $r = \pm 0''296$; the slight diminution in the value of r indicating that the weights assigned to stars remote from the pole are too small rather than too great. From all of the resid-

uals I obtain $r = \pm 0.''317$ whence the probable error of any one of the values of φ' in Table II is approximately $\pm 0.''03$, and assuming $36.''72$ as the mean value, it will be observed that in no case does the residual furnished by a value of φ' exceed this amount. The probable error of the mean is $r_0 = \pm 0.''012$. From the formula for the weights it appears that a determination of unit weight is the equivalent of 1.19 observations U. C. and L. C. of a star near the pole and for this zenith distance the probable error of a single observation is $r_1 = \pm 0.''486$, a number which represents the effect of division error, errors in the refraction tables and any error which may exist in the assumed periodic variation of the latitude in addition to what is commonly called the probable error of an observation.

The following comparison of the actual distribution in point of magnitude of the residuals furnished by the several stars, with the theoretical distribution according to the Gaussian law of error is based on the supposition that the actual residual of an observation of unit weight may be found with sufficient precision for the present purpose by multiplying the residual, v, furnished by each star, by the square root of its weight. The residuals whose distribution is exhibited in the following table are the products obtained by this multiplication.

TABLE III.

Limits.	*No. of Residuals.* Actual.	Theoretical.	Difference.
0.0....0.1	11	15.4	+4
0.1....0.2	15	14.6	−0
0.2....0.3	14	13.4	−1
0.3... 0.4	16	11.7	−4
0.4....0.5	10	9.8	−0
0.5....0.6	9	7.8	−1
0.6....0.7	6	5.9	−0
0.7....0.8	4	4.3	+0
0.8... 0.9	2	3.0	+1
0.9....1.0	1	2.0	+1
1.0.... ∞	3	3.0	0

There are here two cases of serious disagreement between fact and theory, but this is perhaps no more than should be expected with so small a number of residuals as 91. It will be noticed that the excess of large residuals frequently found in practice is here entirely wanting.

We have now to consider to what extent the latitude results thus derived may be affected by systematic error, and of the possible sources of such error five deserve especial notice, viz.:

(*a.*) Personal error of the observers.
(*b.*) Error in the assumed flexures.
(*c.*) Error in the adopted refraction (Pulkowa Tables).
(*d.*) Error in the assumed temperatures of the air.
(*e.*) Error in the adopted atmospheric pressure.

These I proceed to consider *seriatim.*

(*a.*) Personal Error of the Observers. Any constant error peculiar to an observer will be eliminated from his results for latitude and declination since it affects both nadir and stars alike. Any personal error whose effect varies for stars in different declinations will be indistinguishable from a flexure term and need not be further considered here.

The only remaining type of error of this class is a constant error affecting all star observations and a different constant error affecting observations of the nadir. That errors of this kind are present in the observations seems to be indicated by the personal differences derived above and the magnitude of the resulting personal corrections is the only clue, and that an uncertain one, to the probable magnitudes of the errors. If we treat these corrections as residuals and derive from them a probable personal error of the observer we shall obtain for the mean of B and E $r = \pm 0.''046$. In the case of B it appears probable from the observation of zenith stars that the undetermined part of his personal error arises wholly from the nadir observation, but for E no such conclusion can be drawn owing to lack of data

It appears that the value $\pm 0.''046$ above derived must be regarded as a mininum value of that part of the probable error arising from personal peculiarities of the observer.

(*b.*) Error in the Assumed Flexures. The effect of the sine flexure upon the latitude derived from observations of a star whose polar distance is p, is $h \cos \varphi \cos p$ where h is the value of the constant. The effect upon the latitude of increasing h by $0.''1$ is represented in Table II, in the column Increment of Flexure. It is evident from this column that the close agreement between the latitude results from stars at different distances from the pole furnishes no assurance that the flexure has been correctly determined. In the derivation of the weights assigned to the individual results the probable error of the adopted flexure constant was assumed to be $\pm 0.''04$ and the probable error of the latitude arising from this source will therefore be $\pm 0.''029$.

The cosine flexure term is almost perfectly eliminated from the results owing to the equal distribution of observations between the two positions of the circle, and the intrinsic probability of the presence of other sensible flexure terms depending upon the multiples of the zenith distance cannot be considered very great; the following table however shows the general nature of the effect which such terms would produce upon the latitude, the tabular number being the ratio of the latitude effect to the coefficient of the term.

EFFECT OF FLEXURE TERMS

STAR'S N. P. D.	2z.		3z.		4z.	
	Sin.	Cos.	Sin.	Cos.	Sin.	Cos.
0°	+1.0	—0.1	+0.6	—0.8	—0.1	−1.0
10	0.9	0.1	0.5	0.7	—0.1	0.8
20	0.8	0.1	0.3	0.4	0.0	—0.2
30	+0.5	- 0.0	+0.0	—0.0	+0.1	+0.5

A comparison of the table with the actual latitude results indicates that flexure terms depending upon cos $2z$ and sin $4z$ may possibly affect the individual observations but are eliminated from the mean latitude, and that the other terms cannot have coefficients greater than 0.″1.

(*c.*) Error in the Adopted Refractions. It is *à priori* probable that the Pulkowa tables will require some modification to adapt them to another locality and one such modification required by theory arises from the different force of gravity at Pulkowa and Madison, in consequence of which equal barometric pressures at the two places do not correspond to equal densities of the atmosphere. This difference in gravity will be fully taken into account by subtracting 64 units of the fifth decimal place from the barometric factor B of the tables or by multiplying the coefficient μ of the table by 1—0.0015. If we put

$$(1+x)\,(1-0.0015)\,\mu = \mu_0 + \triangle\mu$$

in which the quantity x is introduced in order to include in $\triangle\mu$ the total correction required by the table, we may in theory at least derive a value of $\triangle\mu$ from observations of stars at different distances from the pole. Table II shows under the heading *Increment of Refraction* the effect upon the latitudes of assuming $\mu = +0.''10$, and it is evident that the agreement of the latitude results among

themselves will be very appreciably impaired by assigning to the coefficient μ any increment whose absolute value exceeds 0."03 or 0."04, *i. e.* the Pulkowa tables *without correction for gravity* represent the Madison observations between 10° and 78° north zenith distance.

An extended series of observations for the investigation of the refraction south of the zenith, has been made with a modified form of the Loewy prism apparatus attached to the six-inch Clark equatorial telescope of the observatory. The details of this work, together with its definitive results, must be reserved for a subsequent volume; but a provisional result, which will probably be but little changed in the final discussion, has been derived as follows: (Astronomical Journal, No. 261.) Three stars lying near the plane of the equator were so chosen that the distance between each pair of stars composing the triplet was very approximately 120°, and these distances measured with the apparatus. The sum of the three distances is the circuit of the heavens, and the refraction must be so determined that the sum of these distances projected upon the equator shall be 360°. It will be observed that the right ascensions of the stars are wholly eliminated from the final results, and that the declinations are employed only in the computation of the small second order terms, representing the difference between the measured arc and its projection upon the equator. From six such triplets of stars observed at an average zenith distance of 68° I find as the provisional correction to the uncorrected Pulkowa tables,

$$\triangle \mu = + 0''.030 \pm 0''.022.$$

This result, together with that derived from the latitude observations, appears to me to justify the use of the Pulkowa tables unchanged until the definitive result of the equatorial observations shall be available.

(*d.*) Error in the Assumed Temperature of the Air: A systematic error in the temperature with which the refractions are computed produces an effect scarcely distinguishable from that of an erroneous value of the refraction coefficient μ. Compare in Table II the increment of the latitude due to increasing the adopted temperature 1° F. with that due to a change of 0".10 in μ. The close agreement of the latitude results derived from stars at different distances from the pole requires the conclusion that either the assumed refraction and temperature are both in error or that both are substantially correct. The temperature conditions under which the investigation of the refraction by the prism apparatus, above described, was made, were wholly different from those which obtained in the meridian circle room, and especial care was bestowed upon the temperature determinations which were all made by means of a thermometer whirled in the open air at a point remote from any building which could affect its indications by radiation. The errors of this thermometer with reference to an air thermometer standard were carefully determined and the value of $\Delta \mu$ given above is referred to the air thermometer. I therefore con-

clude that the temperatures indicated by the crib thermometer are those with which the refractions for the meridian circle work should be computed, and I adopt as the probable error of the latitude due to uncertainty in both refraction and temperature the probable error above assigned to the determination of the refraction correction, $r = \pm\ 0''.022$.

(*e.*) Error in the Adopted Atmospheric Pressures. No correction has been applied to the barometer readings and none is required since the same barometer was employed in the refraction determination with the equatorial and in connection with the meridian circle work.

Combining the several partial probable errors above derived we obtain

$$r^2 = \overline{0''.012}^2 + \overline{0.046}^2 + \overline{0.029}^2 + \overline{0.022}^2$$

and find as the definitive value of the absolute latitude for the epoch 1889.0

$$43° \; 4' \; 36''.72 \pm 0''.060.$$

By far the larger part of the probable error is due to the assumption made in regard to the personal errors of the observers, an element which is more frequently omitted from consideration. If omitted here the probable error of the adopted result will be reduced to $\pm 0''.038$.

Simultaneous observations by the same observers using the same instrument and including with other data the observations from which the above absolute latitude has been derived when reduced with the declinations of the Berliner Jahrbuch corrected by the formula given by Auwers (Astr. Nachr. No. 2890–91) are elsewhere shown to furnish the latitude 43° 4′ 36″.91. The difference 0″.19 between this value and the absolute value above derived may be due either to systematic error in the star places of the Jahrbuch, to personal errors of the observers, to an erroneous value of the sine flexure of the meridian circle or to a combination of these causes, but it does not appear possible to ascribe it to any other source. If the difference be attributed to error in the flexure constant it will be necessary to increase this constant from + 0″.38 to + 0″.65, a value which it is difficult to reconcile with the observed flexure coefficients.

One possible and *á priori* probable source of error in the adopted value of the latitude requires separate treatment. To each declination observation included in the above table there has been applied a correction for periodic variation of the latitude of the form

$$\Delta\delta = +\ 0''.26 \sin{(L + 62°)}$$

i. e., the latitude is assumed to be subject to an annual variation which is represented as a function of the sun's longitude. Researches published subse-

quent to the date at which the preceding discussion was made may be thought to render this assumption improbable, although the actual character of the variation is at least roughly represented by the formula. I have therefore made a rediscussion of the observations, omitting all correction for periodic variation of the latitude, but in all other respects saving those noted below following the methods indicated above. The results of the discussion are contained in the following tables concerning which it is to be noted that in the case of a few very close circum-polar stars, which have occasionally been observed twice at the same culmination the mean of these determinations is counted as a single observation in the preceding discussion, while each is considered a separate observation in taking the means exhibited in the following table. The same weights are, however, assigned to the mean results from these stars in both discussions. Stars remote from the pole have *not* received diminished weight as explained on p. 85, but the tabular weights have been adopted for all stars. Two stars omitted from the preceding discussion on account of the small number of observations available have been included here. The approximate latitude here assumed and to which a correction is to be derived is $\varphi = 43° \ 4' \ 36''.72$.

TABLE IV.—INDIVIDUAL RESULTS FOR LATITUDE.

Without correction for periodic variation of φ.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	″		″		″		″	″
λ Urs. Min	1.0	+0.47	37	−0.30	26	+0.17	15	0.10	+0.38
α Urs. Min	1.3	−0.11	55	−0.20	45	− .31	19	.14	+ .04
51 H. Cephei	2.8	+0.11	26	0.00	20	+ .11	12	.06	+ .06
δ Urs. Min	3.4	+0.19	25	+0.10	22	+ .29	14	.16	+ .05
43 H. Cephei	4.3	−0.01	15	+0.24	16	+ .23	11	.12	− .12
Gr. 750	4.8	+0.31	40	−0.62	34	− .31	18	.14	+ .46
30 H. Camelop	6.9	−0.35	11	+0.31	13	− .04	8	.01	− .33
ε Urs. Min	7.8	+0.05	25	+0.12	27	+ .17	14	.10	− .04
76 Draco	7.9	+0.85	13	−0.60	15	+ .25	9	.14	+ .72
1 H. Draco	8.2	−0.06	27	+0.41	28	+ .35	15	.18	− .24
Br. 2749	9.8	+0.28	15	−0.15	13	+ .13	9	.08	+ .22
23 H. Camelop	10.3	+0.65	12	−0.60	11	+ .05	8	.04	+ .62
Gr. 2900	10.6	+0.19	13	−0.16	12	+ .03	8	.02	+ .18
19 H. Camelop	10.9	+0.12	12	+0.05	12	+ .17	8	.10	+ .04
44 H. Cephei	10.9	+0.74	12	−0.67	12	+ .07	8	.04	+ .70
47 H. Cephei	11.0	−0.81	13	−0.24	10	−1.05	7	.52	− .28
Br. 1508	11.6	−0.46	12	+0.35	18	− .11	8	.04	− .40
4 H. Draco	11.8	−0.55	18	+0.44	18	− .11	11	.04	− .50
4 Urs. Min	11.9	−0.58	13	+0.26	13	− .32	9	.15	− .42
Br. 2777	12.3	+0.57	18	−0.22	12	+ .35	8	.18	+ .40
Gr. 2378	12.3	−0.20	12	−0.07	13	− .27	8	.12	− .06
Gr. 1852	12.5	−0.40	12	+0.17	12	− .23	8	.10	− .28
Gr. 2655	12.5	+0.98	12	−0.85	12	+ .13	8	.08	+ .92
κ Cephei	12.6	+1.13	13	−0.36	12	+ .77	8	.40	+ .74
48 H. Cephei	12.7	+0.07	11	−0.14	12	− .07	8	.02	+ .10
24 H. Camelop	12.9	+0.30	14	+0.12	13	+ .42	9	.22	+ .09
γ Cephei	13.0	+1.01	27	−0.93	28	+ .08	14	.05	+ .97
35 Draco	13.0	+0.46	14	−0.64	13	− .18	9	.08	+ .55

TABLE IV.—INDIVIDUAL RESULTS FOR LATITUDE—Continued.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	"		"		"		"	"
Br. 6	13.7	+0.82	12	−0.80	12	+0.02	8	.02	+ .81
9 H. Draco	13.7	+0.04	21	+0.12	25	+0.16	12	.09	−. 04
19 Urs. Min.	13.8	−0.02	12	+0.02	12	+0.00	8	.01	− .02
Br. 1147	13.9	−0.08	12	+0.56	13	+0.48	8	.25	− .32
η Urs. Min	14.0	−0.40	13	+0.18	12	−0.22	8	.10	− .29
Gr. 848	14.3	−0.34	13	+0.30	12	−0.04	8	.01	− .32
π Cephei	15.2	+0.43	13	−0.39	11	+0.04	7	.03	+ .41
73 Draco	15.4	+0.38	13	−0.26	12	+0.12	8	.07	+ .32
21 Cassiop.	15.6	+0.01	12	−0.60	13	−0.59	8	.28	−0.30
Gr. 1374	15.8	−0.56	11	+0.32	13	− .24	8	.11	− .42
Gr. 1446	16.0	−0.14	12	+0.24	13	+ .10	8	.03	− .19
Gr. 1586	16.6	−0.51	11	+0.58	12	+ .07	7	.04	− .54
31 Cephei	16.8	+0.21	12	−0.14	12	+ .07	7	.04	+ .18
Gr. 2001	17.0	−0.36	12	+0.17	13	− .19	8	.08	− .26
40 Cassiop	17.5	+0.26	12	+0.30	12	+ .56	8	.29	− .02
ψ Draco. aust	17.8	+0.27	13	−0.20	12	+ .07	8	.04	+ .24
Gr. 2029	18.2	−0.61	12	+0.01	13	− .60	8	.29	− .31
24 Cephei	18.2	+0.31	13	−0.18	11	+ .13	7	.08	+ .25
φ Draco	18.7	+0.24	13	−0.06	12	+ .18	8	.10	+ .15
υ Draco	18.9	+0.56	12	−0.29	12	+ .27	8	.14	+ .42
5 H. Camelop.	19.0	+0.06	12	−0 61	12	− .55	8	.26	+ .34
11 Cephei	19.2	+0.70	13	−0.14	11	+ .56	7	.29	+ .42
d Urs Maj	19.7	−0.09	13	+0.28	12	+ .19	8	.10	− .18
λ Draco	20.1	−0.44	10	−0.11	13	− .55	6	.26	− .16
Gr. 1564	20.3	−0.22	13	+0.64	12	+ .42	8	.22	− .43
35 H. Urs Maj	20.3	−0.02	12	−0.22	12	− .24	8	.11	+ .10
22 H. Camelop.	20.6	+0.03	13	+0.26	11	+ .29	7	.16	− .12
43 Camelop	21.0	−1.13	12	+1.02	12	− .11	8	.04	−1.08
ω Draco	21.2	+0.67	12	−0.54	12	+ .13	7	.08	+ .61

TABLE IV.—INDIVIDUAL RESULTS FOR LATITUDE—Continued.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	$p.$	$v.$	$\Delta\delta$
	°	"		"		"		"	"
f Draco	21.8	+0.55	13	−0.19	13	+ .36	8	.19	+ .37
ρ Urs. Maj	21.9	−0.12	12	+0.27	13	+ .15	7	.08	− .19
1 H. Urs. Maj	22.2	−0.18	12	−0.21	12	− .39	7	.18	+ .01
σ^2 Urs. Maj	22.4	−0.48	12	+0.42	12	− .06	7	.02	− .45
ψ Cassiop	22.4	+0.64	12	−0.87	12	− .23	7	.10	+ .75
43 Cassiop	22.5	+0.11	13	−0.52	12	− .41	7	.20	+ .31
8 Draco	23.6	−0.51	11	−0.14	12	− .65	7	.32	− .18
Br. 366	23.6	+0.12	13	−0.48	12	− .36	7	.17	+ .30
41 H. Cephei	22.8	+0.40	12	−0.54	12	− .14	7	.06	+ .47
2 H. Urs. Maj	23.6	−1.00	12	+0.75	14	− .25	7	.12	+ .87
30 H. Urs. Maj	23.9	−0.73	11	+0.27	12	− .46	7	.22	− .50
8 Draco	24.0	+0.02	12	−0.36	12	− .34	7	.16	+ .19
55 Cassiop	24.0	+0.59	13	−0.42	12	+ .17	7	.10	+ .50
36 Camelop	24.3	+0.09	13	−0.42	11	− .33	6	.16	+ .25
Gr. 2640	24.6	+0.68	12	−0.28	9	+ .40	6	.21	+ .48
ι Draco	24.7	+0.22	12	−0.28	12	− .06	7	.03	+ .25
Gr. 1771	25.1	0.00	12	−0.20	12	− .20	7	.09	+ .10
36 Draco	25.6	+0.70	12	+0.11	11	+ .81	7	.42	+ .30
Br. 82	26.3	+0.55	12	−0.32	12	+ .23	7	.12	+ .44
76 Urs. Maj	26.7	+0.02	12	−0.14	12	− .12	7	.05	+ .08
30 Cephei	27.0	+0.93	11	−0.59	9	+ .34	5	.18	+ .76
17 Camelop	27.0	+0.19	13	+0.25	13	+ .44	7	.23	+ .22
12 H. Draco	27.1	−0.33	12	+0.23	11	− .10	6	.04	− .28
Gr. 716	27.1	−0.77	12	+0.25	12	− .52	6	.25	− .51
20 Cephei	27.8	+0.35	12	−0.08	12	+ .27	6	.14	+ .22
4 Cassiop	28.3	+0.90	12	−0.68	12	+ .22	6	.12	+ .79
8 Lyncis	28.4	−0.72	12	+0.38	12	− .34	6	.16	− .55
o Urs. Maj	28.9	−0.06	16	−0.58	5	− .64	8	.31	+ .26

TABLE IV.—INDIVIDUAL RESULTS FOR LATITUDE—Concluded.

Star.	N. P. D.	Above Pole.	Obs.	Below Pole.	Obs.	$-2\Delta\varphi$	p.	v.	$\Delta\delta$
	°	"		"		"		"	"
9 H. Camelop	29.2	−0.57	12	+0.36	12	− .21	6	.10	− .46
Gr. 2125	29.3	+0.65	12	−0.90	13	− .25	6	.12	+ .78
53 Camelop	29.4	−0.02	12	+0.10	13	+ .08	6	.05	− .06
69 H. Urs. Maj	29.5	+0.32	11	−0.56	11	− .24	6	.11	+ .44
10 Camelop	29.7	+0.10	7	−0.13	5	− .03	3	.00	+ .12
Gr. 2164	30.3	−0.94	12	+0.33	13	− .61	6	.30	− .64
2 H. Camelop	30.4	−0.40	12	−0.04	10	− .44	5	.21	− .18
74 Urs. Maj	31.0	−0.25	12	−0.28	12	− .53	6	.26	+ .01

Grouping these results as before we obtain the following tabular summary:

N. P. D.	No. of stars.	Weight.	Observed φ'	Adjusted φ'
° °			"	"
1.0.... 8.2	10	135	36.69	36.68
9.8... 13.0	18	156	36.72	36.71
13.7....18.9	20	160	36.71	36.73
19.0....24.0	22	159	36.77	36.76
24.3....31.0	23	186	36.76	36.78

There is here present a small but well marked dependence of the value of the latitude upon the N. P. D. of the stars but the mean value 36."73 does not differ appreciably from that above derived. The effect of the periodic term appears to be eliminated from the mean result and there seems to be no necessity for changing the definitive latitude resulting from the first discussion. It does not appear practicable to put an interpretation upon the progression exhibited by the adjusted value of φ until the exact character of the periodic variations of the latitude shall have been determined.

ABSOLUTE LATITUDE, 1883–1887.

The observations made with the meridian circle during the years 1883–'87 were mainly directed to the determination of differential star places but with a view to the determination of an absolute latitude a considerable number of observations of Polaris were made both above and below the pole. These observations are contained in Vols. IV and V of Publications W. O. but I have thought it desirable to rediscuss them using the flexure constants and division corrections derived in connection with the work of 1888–'90, and also applying to them the correction for periodic variation of the latituee.

$$\Delta\varphi = -0.''26 \sin (L + 62^\circ.)$$

This correction although of doubtful validity in the observations of latter years seems to be required here since it was derivded from simultaneous observations with the same instrument and by the same observers.

The treatment of the data has followed so closely the lines already set forth that further explanation seems unnecessary. In the following tabular summary of latitude results the several observers are denoted by the initial letters of their names as follows: H. = E. S. Holden, C. = G. C. Comstock, T. = John Tatlock, U. = Milton Updegraff, L. = Alice Lamb.

TABLE V.—POLARIS LATITUDES. 1883–1887.

Circle W. U. C.			Circle W. L. C.			Circle E. U. C.			Circle E. L. C.		
Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.
		″			″			″			″
'83 Oct. 16	T.	36.8	'83 Sept. 25	T.	36.5	'84 July 25	T.	37.7	'84 May 8	H.	36.6
23	T.	38.1	Oct. 15	T.	36.5	26	T.	37.1	June 12	C.	36.1
Nov. 28	T.	37.5	18	T.	36.9	27	T.	38.7	13	C.	37.7
Dec. 4	T.	36.8	19	T.	37.1	Sept. 28	C.	36.7	14	C.	36.6
8	T.	39.0	Nov. 1	T.	37.9	Oct. 2	C.	37.4	Nov. 16	H.	36.6
10	T.	37.7	Dec. 4	T.	37.3	Nov. 17	H.	36.3	17	H.	37.5
'84 Oct. 5	C.	37.8	10	T.	36.8	20	H.	36.1	19	H.	37.3
10	C.	38.2	'84 May 27	H.	37.5	27	H.	36.8	Dec. 2	U.	36.9
19	H.	37.6	Oct. 18	H.	36.9	28	U.	36.3	3	U.	36.4
20	H.	36.8	19	H.	37.2	29	U.	36.7	8	U.	37.0
Oct. 24	H.	36.9	22	H.	37.6	30	H.	37.0	9	U.	36.5

TABLE V.—POLARIS LATITUDES. 1883–1887.—Continued.

Circle W. U. C.			Circle W. L. C.			Circle E. U. C.			Circle E. L. C.		
Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.
		″			″			″			″
'84 Nov. 2	H.	38.0	'84 Nov. 1	H.	36.9	'84 Dec. 2	H.	36.8	'85 Sept. 1	U.	37.0
7	H.	37.3	6	H.	38.0	4	H.	36.7	5	U.	37.4
8	U.	37.8	7	H.	38.0	9	H.	37.1	Oct. 10	U.	37.6
9	H.	37.5	12	H.	36.7	10	H.	36.8	11	U.	37.6
12	U.	37.1	13	H.	38.7	15	H.	37.3	13	U.	36.8
13	H.	37.6	July 4	U.	37.2	17	H.	36.5	15	U.	38.3
Dec. 22	H.	37.6	'85 6	U.	37.5	19	U.	36.5	21	U.	37.5
24	U.	37.8	9	U.	36.8	'85 Jan. 30	C.	36.9	22	U.	37.1
'85 Jan. 9	U.	36.7	12	U.	37.2	Feb. 5	C.	37.3	24	U.	38.1
Feb. 18	C.	37.2	13	U.	36.9	11	C.	37.5	'86 Aug. 2	L.	36.2
19	C.	37.2	Oct. 25	U.	37.6	14	C.	36.9	7	U.	37.9
20	C.	37.6	May 29	U.	36.2	16	C.	37.0	24	U.	37.6
21	C.	37.6	'86 June 3	U.	36.1	26	U.	36.0	25	U.	37.3
22	U.	37.7	July 26	L.	36.8	Mar. 31	U.	36.1	26	U.	37.7
23	C.	38.1	Oct. 7	L.	37.6	April 3	U.	36.2	30	L.	36.4
25	C.	38.1	8	L.	37.8	Oct. 11	U.	37.5	Sept. 4	L.	37.2
April 6	U.	37.0	17	L.	36.9	14	U.	36.8	6	L.	36.7
8	U.	36.3	18	U.	36.0	15	U.	36.5	7	L.	36.3
Oct. 28	U.	36.8	20	L.	35.4	16	U.	36.0	10	L.	37.3
'86 April 5	U.	36.5	21	L.	36.5	17	U.	36.2	14	U.	37.7
8	U.	37.2	26	L.	36.4	23	U.	36.9	15	U.	37.5
16	U.	35.5	27	L.	35.6	24	U.	36.9	23	U.	37.4
18	L.	36.4	28	U.	35.6	'86 Nov. 3	U.	36.7	28	L.	38.7
21	L.	36.3	29	U.	36.4	4	U.	37.0	Oct. 2	L.	38.6
May 6	L.	36.6	30	U.	35.8	6	L.	36.4	4	L.	37.8
15	U.	36.7	Dec. 14	U.	35.7	7	U.	36.2	6	L.	38.6
16	L.	36.7	15	U.	35.4	8	L.	36.6	Nov. 2	U.	36.5
18	L.	36.4				11	L.	36.5	5	U.	36.3

TABLE V.—POLARIS LATITUDES. 1883–1887.—Continued

Circle W. U. C.			Circle W. L. C.			Circle E. U. C.			Circle E. L. C.		
Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.	Date.	Obs'r	φ.
		″						″			″
'86 May 19	L.	35.4				'86 Nov. 12	U.	36.1	'86 Nov. 6	U.	35.9
21	L.	36.4				13	L.	37.4	7	L.	37.5
23	L.	35.5				15	L.	37.3	10	L.	37.2
25	L.	35.9				21	U.	36.5	11	L.	37.1
27	U.	37.1				26	U.	36.6	12	L.	37.8
30	U.	36.3				Dec. 4	L.	36.6	13	U.	37.2
Oct. 26	U.	35.1				6	L.	37.3	14	L.	36.9
27	L.	35.1							18	L.	37.2
28	L.	35 0							19	L.	38.5
29	U.	34.6							28	L.	36.6
30	U.	35.0									
Dec. 8	L.	36.7									
20	L.	37.0									
'87 Feb. 8	L.	35.6									
16	U.	36.4									

The means of the several series are:

Above pole.	Circle W.	φ = 43° 4′ 36.″84	54	Observations.
" "	" E.	36.79	46	"
Below pole.	" W.	36.84	38	"
" "	" E.	37.22	49	"
Resulting Latitude		43 4 36.92 ± 0.″037		

The character of the results suggests that the observations below pole Circle E. may be affected by some unknown source of error and that the mean of the other results should be adopted as the latitude resulting from the star but the observation of other stars given below do not confirm this supposition and I therefore adopt the simple mean of the four results here given.

From the 187 residuals furnished by these observations I obtain ± 0.″50 as the probable error of a single observation and ± 0.″037 as the probable error of the mean.

During the years 1884–85 a limited number of circumpolar stars were observed in connection with the observations of the 303 fundamental stars for the southern zones of the *Astronomische Gesellschaft*. The differential declintions of these stars referred to Auwers' system (*Fund. Cat. A. G. Pub. XIV*), are contained in Vol. IV of the Publications of the Washburn Observatory, and from this volume I have selected all those stars which have been observed two or more times both above and below pole and from the original reduction sheets have obtained absolute declinations of these stars using an assumed latitude of 43° 4′ 36.″72. The apparent corrections to the positions of these stars given in the Berliner Jahrbuch are contained in the following table in which the Polaris results above derived are also included for the sake of completeness. It should be noted that the $\Delta\delta$ derived from observations below pole is the correction to the declination reckoned through the pole and its sign must be changed in order to obtain the correction to the ephemeris place. The adopted weights, p, are taken from the table at p. 85. The corrections for periodic variation of latitude have been applied.

TABLE VI.—INDIVIDUAL RESULTS FOR LATITUDE. 1883–1887.

Star.	N. P. D.	Above pole.	Obs.	Below pole.	Obs.	$-2\Delta\varphi$.	p.	v.	$\Delta\delta$.
	°	″		″		″		″	″
α Urs. Min	1.3	+0.18	100	−0.03	87	+0.15	29	+0.03	+0.10
76 Draco..................	7.9	+ .05	15	− .16	9	− .11	7	− .10	+ .10
47 H. Cephei...............	11.0	− .10	2	+ .15	2	+ .05	2	− .02	− .12
4 H. Draco................	11.7	− .28	5	+ .16	4	− .12	3	− .11	− .22
γ Cephei	13.0	+ .73	4	−1.17	2	− .44	2	− .26	+ .95
Gr. 966..................	15.0	+ .79	2	− .69	7	+ .10	2	.00	+ .74
Gr. 1586..................	16.6	− .22	4	+ .38	3	+ .16	2	+ .08	− .30
24 Cephei.................	18.2	− .06	5	− .52	2	− .58	2	− .34	+ .28
σ² Urs. Maj...............	22.4	+ .10	6	+ .85	7	+ .95	4	+ .42	− .38

The data is not sufficient in amount to admit of profitable grouping in zones but the sequence of signs in the column of residuals does not indicate any considerable variation of the latitude with the N. P. D. of the stars observed. I therefore adopt as the definitive result of this determination

$$43° \ 4' \ 36.''95 \pm 0.''063$$

where the probable error includes the same sources of systematic error as are considered at p. 92. The residuals themselves furnish $\pm 0.''26$ as the probable error of a determination of unit weight and $\pm 0.''036$ as the probable error of the mean.

The adopted mean differs by $0.''23$ from the latitude resulting from the observations of Brown and Egbert, a quantity which is nearly four times the probable error of either determination and which points to the existence of some source of systematic error whose nature I cannot even conjecture unless it lie in the nadir observations; but before deciding upon this matter it will be necessary to consider the relative latitudes obtained with the same instrument.

CHAPTER II.

RELATIVE LATITUDES (Meridian Circle).

The *Astronomische Nachrichten, No. 3031*, contains a brief discussion of the latitudes determined with the meridian circle in the years 1883–'87. Since the date of that discussion a large amount of additional data, both latitude observations and investigations of the instrument, has become available and I have endeavored to combine all of this material into a single discussion as nearly homogeneous as the varying character of the data will permit, following the same principles which were adopted in the earlier discussion, but making use of the later determinations of the division corrections and flexure.

The following statement of the general character of the earlier observations and of the method of treatment adopted is taken from the *Astronomische Nachrichten, loc. cit.*

The observations of 1883 were made by Mr. John Tatlock in pursuance of a plan prepared by Professor Holden, whose intention was to make the latitude depend upon the declinations of stars selected from the Berliner Jahrbuch. For this purpose certain groups consisting of two stars north and two south of the zenith were selected by Professor Holden and their observation commenced by Mr. Tatlock in September 1883. This program was never completed, being abandoned shortly after the Observatory undertook the observation of the 303 fundamental stars for the southern zones of the Astronomische Gesellschaft, and the results of the observations have not hitherto been published.

The major part of the observations made during 1884–85, was in prosecution of the 303 star work, and the results are not well adapted to a determination of latitude, since the fundamental stars observed are very unsymmetrically distributed with respect to the zenith. The discussion of these observations has presented greater difficulties than occur in any other part of the work, and the principles finally adopted for the treatment of the entire series of observations, are based upon a consideration of the defects inherent in this part of it. During the latter half of 1885, a series of observations was undertaken by Mr. Updegraff, following essentially the plan pursued by Mr. Tatlock, but comprising a much greater number of stars and carried out more completely. A continuation of these latitude determinations upon essentially the same system, constitutes the greater part of the work done with the meridian circle during the years 1886–87.

Beginning with November, 1887, and including the years 1888–89–90, the latitude results are derived from observations whose primary purpose was the determination of corrections to the positions of the *Zusatzsterne* of the *Fundamental-Catalog* of the *Astronomische Gesellschaft* but a large number of observations of *Hauptsterne* are included in the data. All of the latitudes thus derived depend upon the declinations of the Berliner Jahrbuch which are assumed as fundamental.

I have discussed all of these observations in accordance with the following principles. No corrections for flexure or for error of the adopted refractions, of the Pulkowa table, are to be applied but a value of the latitude is to be derived without such corrections from the observations of every night upon which two or more fundamental stars were observed on each side of the zenith and a nadir was observed before and after the star observations. No determination of latitude which does not satisfy these conditions is to be employed.

The values of the equator point derived from the several stars observed are to be combined in such a manner as to give equal weights north and south of the zenith.

In the discussion of the 1884–85 work the equator points from the several stars were united into three groups corresponding to the average declinations 90°, 48° and —5° and the simple mean of these three values adopted as the

definitive value of the equator point for the night. For the later observations a more symmetrical grouping was in general practicable.

The value of the nadir point employed was for each night a simple mean of all the nadirs observed during the progress of the star observations. To the observed nadir points the following corrections for division error and cosine flexure have been applied:

$$\text{Circle W. } \Delta\, N = -0''.40 \quad \text{Circle E. } \Delta\, N = -0''.40.$$

These corrections are derived by combining the investigation contained in Publications, Vol. V., with the determinations of division error made by Professor Brown in 1888-90. The assumed zero to which the corrections are referred is the mean of all the 10′ diameters of the circle. No corrections for division error have been applied to the star observations.

The above program has been rigorously followed and no observation which satisfies its requirements has been rejected, but in a few cases where the available material is very scanty a value of the latitude has been derived from nights on which, on one side of the zenith, only a single star was observed.

To the latitude resulting from the observations of each night there has been assigned a weight determined by the formula

$$p = \frac{2\,m\,n}{4\,m + n}$$

where n represents the number of fundamental stars observed and m the number of nadir determinations on the night. This is nearly equivalent to adopting as the unit of weight a determination based upon the observation of three fundamental stars and two nadirs:

The several columns of the following table of results will be sufficiently understood from their headings:

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadirs.	Stars.	Sid. Time.	φ'	p
							h	"	
1883	Sept.	25	W.	T.	2	4	13.5	36.16	1.3
	Oct.	3	W.	T.	2	3	18.4	36.45	1.1
		10	W.	T.	2	4	18.8	36.30	1.3
		15	W.	T.	2	2	18.5	36.24	0.8
		16	W.	T.	2	4	14.0	36.21	1.3
		19	W.	T.	3	3	14.0	36.34	1.2
	Nov.	28	W.	T.	3	3	23.6	36.41	1.2
	Dec.	4	W.	T.	4	4	3.5	36.39	1.6
		5	W.	T.	3	3	0.7	36.21	1.1
1884	May	8	E.	H.	2	10	12.7	36.70	2.2
		10	E.	H.	2	24	13.4	36.24	3.0
		13	E.	H.	2	23	13.8	36.60	3.0
		15	E.	H.	2	19	17.3	36.17	2.8
		19	E.	H.	2	17	17.2	36.41	2.5
		26	W.	H.	2	3	12.5	37.01	1.1
		27	W.	H.	2	10	13.4	37.12	2.2
		30	W.	H.	2	13	13.2	37.24	2.5
	June	3	W.	H.	2	15	13.7	36.83	2.7
		5	W.	H.	2	18	15.1	36.90	2.8
		6	W.	C.	3	21	14.9	36.24	3.0
		7	W.	C.	3	22	15.0	37.33	3.0
		9	W.	C.	2	15	16.8	36.22	2.8
		10	W.	C.	2	16	17.6	37.30	2.6
		11	W.	C.	3	18	16.9	37.57	3.0
		12	E.	C.	3	7	14.7	36.26	2.2
		13	E.	C.	3	9	14.8	36.40	2.5
		14	E.	C.	3	9	14.8	37.10	3.6
		16	E.	T.	2	4	18.2	36.23	1.3
		21	E.	C.	2	25	20.6	36.08	3.0

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWER'S DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadirs.	Stars.	Sid. Time.	φ'	p.
							h.	″	
1884	July	9	E.	C.	3	13	18.2	36.02	3.0
		9	E.	T.	2	3	18.2	36.02	1.0
		10	E.	C.	3	20	18.2	35.68	4.0
		10	E.	T.	2	4	18.2	36.75	1.3
		12	E.	C.	2	26	21.7	35.64	3.0
		13	W.	C.	3	11	17.4	37.11	3.0
		18	W.	C.	2	11	19.6	36.74	2.2
		19	W.	C.	2	10	23.0	36.67	2.1
		20	W.	C.	5	21	20.2	36.82	3.0
		25	E.	C.	2	15	22.7	35.78	2.7
		25	E.	T.	2	4	0.6	37.06	1.3
		26	E.	C.	2	16	22.7	36.79	2.6
		26	E.	T.	2	4	0.8	36.37	1.3
		27	E.	C.	2	12	23.0	36.10	2.4
		27	E.	T.	2	4	0.8	37.16	1.3
		30	W.	C.	2	19	22.8	35.89	2.9
		31	W.	C.	2	19	20.5	37.02	2.9
	Sept.	8	W.	C.	2	17	21.0	36.99	2.7
		9	W.	C.	2	17	21.4	37.34	2.7
		11	W.	C.	2	16	20.8	37.54	2.7
		12	W.	C.	2	14	1.6	35.85	2.6
		17	W.	C.	2	15	1.2	36.51	2.6
		19	W.	C.	2	17	1.4	36.99	2.7
		24	E.	C.	2	16	1.4	34.99	2.6
		28	E.	C.	2	13	1.5	35.58	2.4
	Oct.	2	E.	C.	2	12	1.8	36.71	2.4
		5	W.	C.	2	15	1.9	36.66	2.5
		10	W.	C.	2	16	1.7	37.27	2.5
	Nov.	6	W.	H.	2	16	4.1	36.39	2.5

TABLE VII. — LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadirs.	Stars.	Sid. Time.	φ'	p.
							h.	"	
1884	Nov.	7	W.	H.	2	29	4.4	37.05	3.0
		11	W.	H.	2	26	4.6	35.34	3.0
		13	W.	H.	2	21	4.5	36.18	2.9
		15	E.	H.	2	17	3.4	35.78	2.8
		20	E.	H.	2	20	4.1	36.38	2.0
		30	E.	H.	2	8	3.8	35.62	2.0
	Dec.	2	E.	H.	3	11	3.2	36.12	2.9
		3	E.	H.	2	8	3.6	35.89	2.0
		9	E.	H.	2	12	3.5	36.10	2.4
1885	Feb.	26	E.	H,	2	14	7.2	35.79	2.6
	Mch.	7	E.	C.	2	8	8.4	36.57	2.0
		8	E.	C.	2	8	8.4	36.81	2.0
		9	E.	C.	2	8	8.4	36.77	2.0
		10	E.	C.	2	8	8.3	36.30	2.0
		11	E.	C.	2	8	8.5	37.35	2.0
		16	W.	C.	2	8	8.5	37.57	2.0
		19	W.	C.	2	8	8.4	37.11	2.0
		20	W.	C.	2	8	8.4	37.17	2.0
		21	W.	H.	2	10	8.2	36.83	2.2
		22	W.	C.	2	8	8.4	36.92	2.0
		24	E.	C.	2	8	8.4	36.34	2.0
		28	E.	H.	2	16	8.7	36.34	2.7
	Apr.	3	E.	H.	2	14	9.3	36.60	2.6
		4	E.	H.	2	6	9.2	36.48	1.7
		5	W.	H.	2	5	9.2	36.54	0.5
		13	W.	H.	2	4	9.4	36.83	0.5
		28	W.	H.	2	14	10.8	37.24	2.6
	May	4	W.	H.	2	6	10.5	38.05	1.5
		10	W.	H.	2	10	11.5	37.58	2.2

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadirs.	Stars.	Sid. Time.	φ'.	p.
							h.	″	
1885	May	21	E.	H.	3	12	13.0	36.84	3.0
		22	E.	H.	2	17	14.0	36.75	2.6
		23	E.	H.	2	14	15.4	36.77	2.5
		25	W.	H.	3	27	14.8	36.43	4.0
		30	W.	C.	4	32	18.8	36.67	5.0
	June	1	E.	C.	8	25	15.0	36.60	7.0
		8	E.	U.	5	7	19.0	37.39	2.8
		10	E.	U.	5	19	19.2	36.72	4.7
		13	E.	C.	4	33	19.0	36.68	5.3
		18	E.	U.	5	21	18.9	37.09	5.0
		21	E.	C.	5	31	19.0	36.88	6.0
		25	W.	C.	5	31	19.1	36.42	6.0
		29	W.	C.	5	31	19.0	36.05	6.0
	July	3	W.	U.	4	18	18.0	36.80	4.2
		9	W.	U.	5	23	18.9	37.27	5.2
		11	W.	U.	5	12	18.7	36.63	4.0
		13	W.	U.	5	15	19.0	37.14	4.5
		14	W.	U.	2	7	20.8	37.19	1.8
		15	W.	U.	2	9	20.6	36.27	2.2
	Aug.	10	E.	H.	2	11	20.6	36.55	2.3
	Oct.	29	W.	U.	2	11	7.1	36.16	2.3
	Nov.	4	W.	U.	2	16	6.4	36.14	2.6
		9	W.	U.	2	21	6.6	36.05	3.0
		15	W.	U.	2	15	6.7	36.01	2.6
		16	E.	U.	2	20	6.8	36.26	2.5
		20	E.	U.	2	18	6.7	35.92	2.7
	Dec.	2	E.	U.	2	19	9.7	35.80	2.9
		18	W.	U.	2	18	9.3	36.11	2.8
		19	W.	U.	2	8	10.3	36.69	2.0

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.	Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
					h.	″	
1885 Dec. 25	E.	U.	2	9	10.6	36.45	1.0
1886 Nov. 26	E.	U.	5	19	23.8	36.42	5.0
Dec. 3	E.	U.	4	35	23.5	36.70	5.5
4	E.	U.	5	37	23.1	36.83	6.5
6	E.	U.	5	36	23.1	36.42	6.5
7	W.	U.	3	27	23.1	36.51	4.2
8	W.	U.	5	35	23.1	36.75	7.0
9	W.	U.	4	29	23.6	36.96	5.2
20	W.	U.	2	9	0.7	37.39	2.1
21	W.	U.	3	26	2.5	36.38	4,8
22	W.	U.	3	26	2.5	36.47	4.0
1887 Feb. 8	W.	U.	3	13	5.4	35.84	0.0
9	W.	U.	3	24	5.9	37.09	4.0
15	W.	U.	4	26	6.1	36.68	5.0
16	W.	U.	5	29	6.2	36.64	5.9
28	E.	U.	5	27	6.2	36.82	5.8
March 1	E.	U.	5	29	6.2	36.81	5.9
10	E.	U.	3	23	6.6	36.68	4.0
April 18	W.	U.	5	40	11.8	36.88	6.7
25	W.	U.	5	40	11.8	36.47	6.7
30	W.	U.	5	36	11.8	37.03	6.5
May 3	E.	U.	5	40	11.8	36.87	6.7
6	E.	U.	5	40	11.8	36.75	6.7
7	E.	U.	5	40	11.8	36.53	6.7
9	E.	U.	5	38	11.8	36.73	6.6
10	W.	U.	5	40	11.8	37.08	6.7
12	W.	U.	5	38	11.8	36.98	6.6
June 15	W.	L.	2	14	15.4	37.30	2.5
16	W.	L.	3	9	15.7	37.40	2.6

TABLE VII.— LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
							h.	"	
1887.	June	17	W.	L.	2	11	15.3	37.72	2.3
		23	E.	L.	3	9	16.0	36.08	2.6
		24	E.	L.	3	18	15.8	36.16	3.6
		25	E.	L.	3	19	15.7	36.06	3.7
	July	7	W.	L.	2	4	16.5	36.83	1.3
		11	W.	L.	2	8	16.5	36.79	2.0
	Aug.	4	W.	L.	3	12	17.8	36.28	2.9
		6	W.	L.	3	15	17.8	36.17	3.3
		18	E.	L.	3	14	18.1	35.64	3.2
		23	E.	L.	3	14	18.1	36.23	3.2
		29	E.	L.	3	14	18.1	35.84	3.2
		30	W.	L.	3	13	18.2	36.24	3.1
	Nov.	1	W.	B.	2	7	23.9	36.85	2.0
		2	W.	B.	2	8	23.2	37.34	2.0
		3	W.	B.	2	12	0.0	37.22	2.4
		10	W.	B.	2	7	1.6	36.71	1.9
		15	W.	B.	2	7	1.0	37.32	1.9
		17	W.	B.	2	7	1.2	36.82	1.9
		28	W.	B.	2	7	1.8	37.02	1.9
	Dec.	13	W.	B.	2	10	2.2	36.95	2.2
		29	W.	B.	2	12	2.7	37.31	2.4
1888.	May	14	W.	B.	2	33	13.8	37.19	3.2
		15	W.	B.	2	25	13.6	36.91	3.0
		16	W.	E.	2	32	13.8	36.16	3.2
		19	W.	B.	2	23	14.0	37.54	3·0
		21	W.	E.	2	33	14.7	37.10	3.2
		25	W.	B.	3	36	14.7	37.48	4.5
		28	W.	E.	2	27	17.0	36.65	3.1
		29	W.	B.	3	32	14.7	37.59	4.4

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.	Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
					h.	″	
1888. May 30	W.	E.	3	32	15.1	38.04	4.4
31	W.	B.	3	21	14.0	37.46	3.8
June 2	W.	E.	3	34	14.8	37.17	4.5
4	W.	B.	3	35	15.1	37.29	4.5
6	W.	E.	3	21	16.2	36.59	3.8
7	W.	B.	3	16	16.4	36.79	3.4
8	W.	E.	3	34	15.2	37.14	4.5
15	W.	B.	3	28	16.6	36.56	4.2
16	W.	E.	3	35	16.7	37.14	4.5
21	W.	B.	2	6	15.0	36.99	1.7
22	W.	E.	2	26	16.8	36.31	3.1
23	W.	B.	2	34	18.0	36.92	3.2
30	W.	E.	2	20	17.1	37.37	2.9
July 2	W.	B.	2	31	18.4	36.94	3.1
9	W.	E.	2	28	18.4	36.44	3.1
10	W.	B.	2	34	18.4	36.52	3.2
11	W.	E.	3	41	19.6	36.78	4.7
15	W.	B.	2	20	18.7	36.72	2.8
17	W.	E.	3	38	19.6	36.13	4.6
18	W.	B.	3	42	19.6	36.84	4.7
19	W.	E.	2	22	20.2	36.53	2.8
20	W.	B.	3	36	19.8	36.54	4.6
21	W.	E.	2	13	18.7	36.78	2.5
24	W.	B.	2	16	18.6	36.41	2.6
26	W.	E.	3	35	19.6	36.45	4.5
27	W.	B.	2	25	20.0	36.03	3.0
28	W.	E.	2	36	20.8	36.45	3.3
30	W.	B.	2	11	20.1	36.40	2.3
Aug. 2	W.	E.	2	13	20.6	36.08	2.5

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
							h.	′	
1888.	Aug.	3	W.	B.	3	35	21.2	36.83	4.6
		4	W.	E.	2	19	20.6	35.72	2.8
		6	W.	B.	2	35	21.2	36.49	3.3
		8	W.	E.	2	30	21.7	36.25	3.2
		16	W.	B.	2	41	22.0	36.13	3.4
		17	W.	E.	2	42	22.2	36.04	3.4
		20	W.	B.	2	34	22.3	36.14	3.3
		21	W.	E.	2	30	22.8	37.27	3.3
		22	W.	B.	3	48	23.3	36.11	4.8
		23	W.	E.	3	48	23.3	36.42	4.8
		24	W.	B.	2	21	23.2	36.77	2.9
		27	W.	E.	2	20	22.0	36.75	2.9
		29	W.	B.	2	33	23.9	36.92	3.3
		31	W.	E.	2	15	23.0	35.72	2.6
	Sept.	1	W.	B.	3	38	0.0	36.42	4.6
		4	W.	E.	2	38	0.2	36.25	3.3
		5	W.	E.	2	31	0.1	36.29	3.2
		6	W.	B.	2	26	0.1	36.64	3.0
		8	W.	E.	2	29	0.6	36.66	3.1
		11	W.	B.	3	39	2.2	37.46	4.6
		12	W.	B.	2	24	1.3	36.43	3.0
		13	W.	E.	3	46	2.0	36.57	4.8
		19	W.	B.	3	47	2.3	37.10	4.8
		23	W.	E.	3	56	2.9	36.65	4.9
	Oct.	7	W.	B.	2	17	1.9	37.52	2.7
		8	W.	E.	3	51	3.2	37.00	4.9
		9	W.	B.	2	12	2.0	36.78	2.4
		13	W.	B.	3	26	2.2	36.31	4.1
		15	W.	E.	3	36	2.6	36.56	4.6

TABLE VII.--LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadirs.	Stars.	Sid. Time.	φ″.	p.
							h.	″	
1888	Oct.	16	W.	B.	3	30	3.0	36.66	4.3
		30	W.	B.	2	24	4.6	36.89	3.0
	Nov.	2	W.	E.	3	45	5.4	36.46	4.8
		10	W,	B.	3	63	5.8	37.23	5.0
		12	W.	E.	2	60	6.1	36.56	3.5
		16	W.	B.	2	25	5.2	36.69	3.0
		19	W.	E.	2	68	6.2	37.36	3.5
		22	W.	B.	2	57	6.4	37.30	3.5
		23	W.	B.	2	62	6.9	36.82	3.5
		30	W.	E.	2	60	7.8	37.16	3.5
	Dec.	3	W.	B.	2	27	6.9	36.89	3.1
		8	W.	B.	2	42	7.6	37.06	3.4
		10	W.	E.	2	45	8.2	37.27	3.4
		29	E.	B.	2	43	2.5	37.67	3.4
1889	Jan.	2	E.	E.	2	40	2.6	37.20	2.6
		3	E.	B.	2	18	2.1	37.37	2.1
		10	E.	B.	2	18	3.4	36.84	2.1
		22	E.	B.	2	42	5.5	37.79	3.4
		23	E.	E.	2	52	5.8	37.82	3.5
	Feb.	1	E.	B.	2	15	4.4	37.61	2.6
	March	19	W.	B.	3	37	10.4	36.73	4.5
		20	W.	B.	3	27	9.1	37.26	4.2
		21	W.	B.	3	45	9.7	37.38	4.7
		22	W.	E.	3	60	10.7	37.22	5 0
		23	W.	B.	3	54	10.8	36.80	4.9
		25	W.	E.	2	14	9.0	36.87	2.5
		29	W.	E.	3	54	10.8	38.02	4.9
	Apr.	2	W.	B.	2	22	9.9	36.46	2.9
		4	W.	B.	3	23	10.2	36.93	3.9

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
							h.	″	
1889	Apr.	5	W.	E.	2	44	11.9	37.64	3.4
		15	W.	E.	3	36	11.9	36.51	4.4
		19	W.	B.	4	37	11.7	36.97	5.5
		21	W.	E.	3	39	13.7	37.39	4.5
		25	W.	B.	3	24	14.8	36.27	4.0
		30	E.	E.	3	45	13.8	37.63	4.7
	May	3	E.	B.	3	48	13.7	36.84	4.7
		6	E.	E.	3	54	13.7	36.98	4.9
		23	E.	B.	3	45	14.6	37.22	4.7
		25	E.	E.	3	43	14.5	37.58	4.6
		27	E.	B.	3	47	14.4	36.98	4.7
	June	5	E.	E.	3	49	15.1	36.79	4.8
		11	E.	B.	3	43	15.2	36.72	4.6
		12	E.	E.	3	25	14.6	37.11	4.1
		16	E.	B.	3	43	15.4	37.40	4.6
		19	E.	E.	3	54	16.9	36.89	4.9
		25	E.	B.	3	34	18.2	36.05	4.4
		29	E.	E.	3	56	17.8	36.58	4.9
	July	1	E.	B.	3	46	17.8	36.25	4.7
		5	E.	E.	3	50	17.8	36.55	4.8
		7	E.	B.	3	45	17.8	36.23	4.7
		10	E.	E.	3	51	17.7	37.02	4.8
		23	E.	E.	3	28	18.0	36.03	4.2
	Aug.	2	E.	B.	3	64	22.4	36.64	5.1
		4	E.	E.	4	72	22.4	36.52	6.5
		5	E,	B.	4	70	22.4	36.23	6.5
		11	E.	E.	2	19	20.4	36.13	2.9
		15	E.	E.	4	76	22.6	36.41	6.5
		21	E.	B.	4	68	23.0	36.25	6.3

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.			Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
							h.	′	
1889	Aug.	22	E.	E.	4	75	22.6	36.19	6.5
		24	E.	B.	4	67	22.4	36.04	6.4
		27	E.	B.	4	60	22.4	36.13	6.2
		29	E.	E.	4	64	22.4	36.41	6.3
	Sept.	20	E.	B.	4	67	22.5	36.29	6.4
		21	E.	B.	4	24	23.6	35.62	4.8
		27	E.	B.	4	50	22.3	36.49	6.1
	Oct.	1	E.	B.	3	29	2.5	36.87	4.3
		4	E.	B.	3	32	2.3	36.70	4.8
		7	E.	B.	3	29	2.5	36.05	4.3
		9	E.	B.	3	31	2.5	36.46	4.3
		13	E.	B.	3	34	2.3	37,22	4.4
		14	E.	B.	3	22	2.2	36.54	4.0
		17	E.	B.	3	30	2.6	36.99	4.3
		18	E.	B.	3	25	2.5	36.32	4.1
		20	E.	B.	3	29	3.1	36.99	4.3
		29	E.	B.	3	27	3.5	36.79	4 2
	Nov.	5	E,	B.	2	19	5.1	36.27	2.8
		6	E.	B.	3	20	5.0	36.95	3.8
		9	E.	B.	4	41	5.8	36.95	5.6
		16	E.	B.	3	45	5.8	36.61	4.7
		17	E.	B.	3	35	5.4	36.39	4.4
		25	E.	B.	3	24	5.2	36.54	4.0
		30	E.	B.	3	29	5.9	36.68	4.3
	Dec.	6	E.	B.	3	42	5.8	36.73	4.6
		8	E.	B.	3	42	5.9	37.23	4.6
		12	E.	B.	3	31	6.3	36.76	4.3
		18	E.	B.	3	35	5.9	37.14	4.4
		22	E.	B.	3	32	6.6	37.05	4.3

TABLE VII.—LATITUDE RESULTS REFERRED TO AUWERS' DECLINATION SYSTEM.

Date.	Circle.	Obs'r.	Nadir.	Stars.	Sid. Time.	φ'.	p.
					h	″	
1889 Dec. 30	E.	B.	3	29	6.6	36.68	4.3
1890 Mar. 12	E.	B.	4	68	9.9	37.09	6.5
15	E.	B.	3	14	7.5	37.02	3.2
17	E.	B.	4	72	10.1	37.11	6.5
21	E.	B.	2	37	8.7	37.07	3.2
26	E.	B,	3	38	9.0	37.19	4.5
28	E.	B.	4	54	10.4	36.96	6.2
29	E.	B.	2	21	8.3	36.83	2.9
31	E.	B.	4	73	10.3	36.99	6.6
April 1	E.	B.	3	30	9.1	36.91	4.3
2	E.	B.	2	18	8.9	36.92	2.8
4	E.	B.	4	58	10.9	36.83	6.3
10	E.	B.	3	49	10.6	36.94	4.8
11	E.	B.	2	13	8.9	37.12	2.4
16	E.	B.	3	41	11.1	36.80	4.5
17	E.	B.	3	37	11.1	36.82	4.4
19	E.	B.	3	21	10.7	36.66	3.9
20	E.	B.	2	14	10.9	36.87	2.5

The numbers of the preceding table represent the latitude of the meridian circle referred to the system of star places of the Berliner Jahrbuch (*Fund. Cat. Pub. XIV. Astron. Gesell.*) or rather to different parts of that system since the distribution of the stars observed in the different years has not been the same, and I proceed now to inquire to what extent the discordances among the values of the latitude may be due to systematic error in the declinations employed. It is commonly understood that the Pulkowa declinations which were selected as the basis for the *Fundamental Catalog* are, for southern stars at least, considerably in error, and that this error increases rapidly as the system is extended toward the southern horizon of Pulkowa. In the *Vorläufiger Fundamental-Catalog für die Südlichen Zonen,* Auwers adopts as the correction for this error the expression

$$+0''.50 - 0''.02\,\delta^\circ$$

accompanying it with the caution that the formula is not valid outside the limits of the catalogue, *e. g.* $+5°$ and $-30°$. A preliminary discussion of the observations with the meridian circle of this observatory having shown that its results for absolute declinations are in substantial accord with the Pulkowa declinations of northern stars, I have decided to provisionally adopt Auwers' expression and to extend it to 25° north declination, assuming the correction beyond that limit to be insensible. It should be observed that the application of this system of corrections to the latitudes furnished by the meridian circle renders them comparable with the latitudes obtained by the Talcott method, to be subsequently discussed, since these latter depend upon declinations of circumzenith stars referred to the A. G. system.

The meridian circle observation of 1884 belong to two quite different classes: First, observation by T. of a set of stars selected with reference to a latitude determination and symmetrically disposed with respect to the zenith. Second, observations by H. and C. for the determination of the places of the 303 fundamental stars for the southern zones of the *Astromonische Gesellschaft*

In the observing list for the first category there occur four stars south of $+25°$ declination and two stars between that limit and the zenith, and the total weight with which the results of T's observing enter into the mean for 1884 is 12.3. The 303 stars are pretty evenly distributed between the limits $+5°$ and $-25°$ declination, and their mean declination may be assumed to be $-10°$. The weight assigned to observations of these stars is 50.5. We obtain therefore as the correction to the latitudes of 1884 due to corrected star places,

$$\frac{+0.''45 \times \frac{4}{6} \times 12.8 + 0.''60 \times 50.5}{62.8 \times 2} - \frac{0.''05 \times 50.5}{62.8 \times 2} = +0.''25.$$

the second term of the expression being due to uncompensated flexure of the instrument arising from the greater average zenith distance of the southern stars (303 stars).

The observations of 1885 and 1886 relate to the 303 stars with the introduction of a few observations of stars near the zenith. In the derivation of the latitudes the latter stars have received a larger weight than would be due to their number of observations on account of the freedom of the results from errors due to flexure and refraction. From an inspection of the computations I estimate the distribution of weights to have been very approximately

South Stars, 2. Zenith Stars, 1. North Stars, 2.

whence the correction to the latitudes of 1885 and 1886 is

$$+0''.60 \times \tfrac{2}{5} - 0''.05 \times \tfrac{2}{5} = +0''.22$$

The observations of 1887 were made with special reference to a determination of latitude and the stars are therefore especially well distributed with respect to

the zenith (*See Publications, W. O., Vol. V., pp. 66, 67 and 3**). In the discussion of these observations the three groups South, Zenith, North have received equal weights. The average declination of the stars south of +25° is —2°, and the correction to the 1887 latitudes is therefore:

$$+0''.54 \times \tfrac{2}{6} = +0''.18$$

The latitude results for 1888, 1889, 1890 are derived from observations whose primary purpose was the determination of corrections to the positions of the *Zusatzsterne* of Auwers' Fundamental Catalog but a large number of observations of *Hauptsterne* are included in the data. The stars observed are pretty uniformly distributed from the pole to the equator and somewhat more sparsely from the equator to —10° declination, the mean declination of the southern stars being approximately +8°. The assignment of weights being the same as in 1887 we have as the correction to the latitudes of 1888, 1889, 1890.

$$+ 0''.34 \times \tfrac{2}{6} + 0''.03 \times \tfrac{2}{6} = + 0.''12,$$

the second term arising, as before, from uncompensated flexure

In one respect the observations of these years are not homogeneous with those of earlier date. In each year prior to 1888 the circle was frequently reversed and the mean result for a year may be considered practically free from the effect of systematic difference between results obtained from Circle W and Circle E, *e. g.*, error in the assumed cosine flexure and division correction of the nadir lines. The observations of 1888 were all made Circle W, those of 1890 are all Circle E, while in 1889 about three-fourths are made Circle E and one-fourth Circle W. The cosine flexure adopted in the derivation of the results, +0''.06, was derived from a discussion of the observations of zenith stars by B and E in the years 1888, '89. The value derived from observations of the nadir, levelled collimators and floating mirror is +0''.11, and for comparison I purpose introducing this value whenever its effect will be sensible.

Combining this correction, $0''.05+(1+\cos z) = + 0''.09$, with the correction for erroneous declination we obtain the resulting corrected φ of the following table, concerning which it should be said that all observations made within six months of the epoch 1884, are united into the mean result for 1884 and similarly for each other epoch. The numbers in the column, Epoch, are therefore not to be construed as denoting the calendar years within which observations were made, but the mean epoch of the group.

The several columns of the table seem to require no explanation beyond the statement that r_1 denotes the probable error of an observation of unit weight and that p and r_0 are the weight and probable error of the adopted value of φ.

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TABLE VIII.—RELATIVE LATITUDES.

Epoch.	No of Nights.	r_1	p	φ	r_0	Corrected φ.
		"		"	"	"
1884.0	29	±0.43	62.8	36.54	±0.056	36.79
1885.0	74	.57	192.9	36.51	.043	36.73
1886.0	17	.45	48.6	36.55	.065	36.77
1887.0	31	.39	157.8	36.66	.031	36.84
1888.0	33	.56	116.9	36.89	.051	36.92
1889.0	94	.60	347.9	36.84	.032	36.92
1890.0	60	.47	273.8	36.69	.029	36.90

The weighted mean of the results for the several years is

$$43^\circ\ 4'\ 36.''86 \pm 0.''015.$$

the probable error being derived from the values of r_0 given in the table. The probable error furnished by the comparison of this adopted value with the several annual results is ± 0.″020.

The apparent increase of the value of φ in the later years covered by the observations requires consideration, but it will be expedient first to take up the problem of short period variations in the latitude.

I have grouped into mean values the latitudes resulting from a number of consecutive determinations, choosing this number so that the weight of the mean may be as nearly as possible 25, without extending the period covered by a group much beyond the limit of twenty days. The means thus determined for each calendar year have been platted, and the results for the several years compared to determine the general character of the periodic variation. Such a variation is clearly indicated by the data, and the latitudes obtained in the first half of the year are in every case greater than those obtained during the second half. Since the observations extend over a period of nearly seven years, it will be impossible to represent such variations in the latitude by means of any period differing much from a year in length, and I have therefore in the following table arranged the data by months regardless of the year in which the observations were made. The column *Corr.* contains the corrections above derived for systematic error of the declinations of the equatorial stars and for uncompensated flexure. The column *Corr'd* φ contains what is supposed to be the best data for an investigation of the short period variations of the latitude, which the observations are capable of affording.

It should be here noted that since the greater part of the observations were made between $6h$ and $12h$ mean solar time a periodic error in the adopted declinations having the form

$$c \cos (\alpha + C)$$

would give rise to an apparent variation of the latitude such as is indicated in the table. The observations themselves cannot be made to distinguish certainly between an error of this kind and a real change of the latitude and in the treatment of the data it is assumed that if such a periodic term exists its coefficient is so small as to be a negligible quantity. The justification or disproof of this hypothesis must be found in a comparison of the variation of the latitude indicated by the data in question with determinations from which the assumed declinations have been eliminated.

TABLE IX.—RELATIVE LATITUDES.

Date.	Obs'r.	Wt.	Obs'd. φ	Corr.	Corr'd φ.	422 day Period.	Annual Period.	v'.	v''.
			′	′	′	′	′	′	′
1889 Jan. 12	B. E.	20	37.41	+0.21	37.62	−0.15	−0.21	+0.61	+0.55
'87 Feb. 23	U.	31	36.78	+ .18	36.96	− .04	− .32	+ .06	− .22
'85 Mar. 12	C.	23	36.76	+ .22	36.98	+ .24	− .32	+ .36	− .20
'90 Mar. 18	B.	24	37.10	+ .21	37.31	− .18	− .31	+ .27	+ .14
'89 Mar. 21	B. E.	23	37.08	+ .03	37.11	− .25	− .30	.00	− .05
'90 Mar. 31	B.	23	36.94	+ .21	37.15	− .20	− .28	+ .09	+ .01
'85 Apr. 2	H.	10	36.46	+ .22	36.68	+ .21	− .27	+ .03	− .45
'89 Apr. 4	B. E.	22	37.13	+ .03	37.16	− .24	− .27	+ .06	+ .03
'90 Apr. 13	B.	29	36.85	+ .21	37.06	− .23	− .24	− .03	− .04
'89 Apr. 24	B. E.	23	37.04	+ .03	37.07	− .22	− .20	− .01	+ .01
'87 Apr. 26	U.	27	36.81	+ .18	36.99	+ .17	− .19	+ .30	− .06
'87 May 9	U.	33	36.81	+ .18	36.99	+ .20	− .13	+ .33	.00
'85 May 14	H.	14	37.11	+ .22	37.33	+ .10	− .10	+ .57	+ .37
'88 May 20	B. E.	23	37.13	+ .03	37.16	+ .07	− .06	+ .37	+ .24
'84 May 21	H.	25	36.69	+ .28	36.97	− .13	− .06	− .02	+ .05
'89 May 23	B. E.	24	37.11	+ .21	37.32	− .12	− .05	+ .34	+ .41
'88 June 1	B. E.	25	37.37	+ .03	37.40	+ .11	.00	+ .65	+ .54
'85 June 2	C. U.	24	36.70	+ .22	36.92	+ .03	+ .01	+ .09	+ .07

TABLE IX.—RELATIVE LATITUDES—Continued.

Date.		Obs'r.	Wt.	Obs'd. φ	Corr.	Corr'd φ	422 day Period.	Annual Period.	v'.	v''
				″	″	″	″	″	″	″
'84	June 12	C.	27	36.71	+ .28	36.99	— .19	+ .06	— .06	+ .19
'88	June 15	B. E.	25	36.81	+ .03	36.84	+ .15	+ .08	+ .13	+ .06
'89	June 17	B. E.	23	36.84	+ .21	37.05	— .04	+ .08	+ .15	+ .27
'85	June 23	C.	28	36.51	+ .22	36.73	— .05	+ .11	— .18	— .02
'87	June 24	L.	21	36.70	+ .18	36.88	+ .25	+ .12	+ .27	+ .14
'89	July 4	B. E.	24	36.53	+ .21	36.74	+ .03	+ .17	— .09	+ .05
'88	July 9	B. E.	24	36.66	+ .03	36.69	+ .21	+ .20	+ .04	+ .03
'85	July 10	U.	22	36.83	+ .22	37.05	— .09	+ .20	+ .10	+ .39
'84	July 12	C. T.	20	36.37	+ .26	36.63	— .21	+ .21	— .47	— .02
'88	July 22	B. E.	25	36.53	+ .03	36.56	+ .24	+ .25	— .06	— .05
'84	July 26	C. T.	20	36.50	+ .26	36.76	— .25	+ .26	— .35	+ .16
'89	Aug. 1	B. E.	22	36.37	+ .21	36.59	+ .13	+ .28	— .14	+ .01
'88	Aug. 3	B. E.	22	36.37	+ .03	36.40	+ .25	+ .28	— .21	— .18
'89	Aug. 18	B. E.	22	36.26	+ .21	36.47	+ .17	+ .31	— .22	— .08
'87	Aug. 18	L.	19	36.06	+ .18	36.24	+ .15	+ .31	— .47	— .31
'88	Aug. 20	B. E.	23	36.34	+ .03	36.37	+ .25	+ .31	— .24	— .18
'89	Aug. 27	B. E.	19	36.20	+ .21	36.41	+ .20	+ .32	— .25	— .13
'88	Aug. 31	B. E.	23	36.46	+ .03	36.49	+ .24	+ .32	— .13	— .05
'88	Sep. 14	B. E.	28	36.82	+ .03	36.85	+ .22	+ .31	+ .21	+ .30
'84	Sep. 21	C.	28	36.59	+ .28	36.87	— .17	+ .30	— .16	+ .31
'89	Sep. 24	B.	22	36.31	+ .21	36.52	+ .24	+ .30	— .10	— .04
'83	Oct. 9	T.	7	36.28	+ .18	36.46	+ .09	+ .26	— .31	— .14
'89	Oct. 9	B.	21	36.60	+ .21	36.81	+ .25	+ .26	+ .20	+ .21
'88	Oct. 12	B. E.	23	36.76	+ .03	36.79	+ .16	+ .24	+ .09	+ .17
'89	Oct. 26	B.	24	36.75	+ .21	36.96	+ .24	+ .19	+ .34	+ .29
'85	Nov. 9	U.	13	36.12	+ .22	36.33	— .19	+ .12	— .72	— .41
'88	Nov. 9	B. E.	23	36.91	+ .03	36.94	+ .07	+ .12	+ .15	+ .20
'87	Nov. 11	B.	14	37.05	+ .03	37.08	— .16	+ .11	+ .06	+ .33
'89	Nov. 19	B.	23	36.65	+ .21	36.86	+ .21	+ .07	+ .21	+ .07

TABLE IX.—RELATIVE LATITUDES—Continued.

Date.	Obs'r.	Wt.	Obs'd. φ	Corr.	Corr'd φ	422 day Period.	Annual Period.	v'.	v''.
'84 Nov. 20	H.	26	36.10	+ .28	36.38	+ .03	+ .06	− .45	− .42
'88 Dec. 1	B. E.	20	37.09	+ .03	37.12	− .01	.00	+ .25	+ .26
'83 Dec. 2	T	4	36.34	+ .18	36.52	+ .22	.00	− .12	− .34
'86 Dec. 3	U.	28	36.59	+ .18	36.77	− .25	− .01	− .34	− .10
'85 Dec. 8	U.	11	36.12	+ .22	36.34	− .11	− .04	− .63	− .56
'86 Dec. 14	U.	22	36.74	+ .18	36.92	− .23	− .07	− .17	− .01
'89 Dec. 16	B.	26	36.93	+ .21	37.14	+ .13	− .08	+ .41	+ .20
'87 Dec. 21	B.	5	37.40	+ .03	37.43	− .23	− .11	+ .34	+ 46

From a graphical treatment of the corrected values of the latitude I find that the data is best represented by an annual variation whose double amplitude is 0."64 and whose maxima and minima fall respectively in March and August. This variation is fairly represented by the equation

$$\varphi = \varphi_0 + 0.''32 \cos(\tau - 0.164)\, 360^\circ$$

where τ is the fraction of the year that has elapsed at any date. The values of the periodic term in this expression are given in the column headed *Annual Period.*

The numbers in the column *422 Day Period* have been derived as follows: From the latitude determinations made at Berlin, Potsdam, Prag and Pulkowa, whose results are contained in Nos. 3025 and 3055 of the *Astronomiche Nachrichten*, I find an apparent period of 422 days in the latitude variation, and using this period to reduce the observed phase of the variation to the meridian of Berlin, I obtain the following dates at which the latitude of Berlin passed through its mean value:

Observations at	1889	1889	1890	1890
Berlin	March 21	Nov. 19	May 28	Dec. 16
Potsdam	Feb. 9	Oct. 27	....	....
Prag	....	Nov. 15	May 3	Dec. 20
Pulkowa	....	....	May 17	....
Adopted	March 1.	Nov. 10.	May 16	Dec. 18

These epochs, together with the observed amplitudes of variation, furnish the following expression for the variation of the latitude corresponding to the form adopted by Chandler (*A. J. No. 249*)

$$\varphi = \varphi_0 - 0''.25 \cos [\lambda + 0^\circ.853 (t - T)]$$

in which the longitudes are reckoned from the meridian of Berlin and T = 2 411 406 in the Julian period. While it may well be questioned if this expression is more than a forced representation of the data from which it was derived it will serve for the present purpose as a summary of that data, and it has been employed in computing the corresponding corrections to the latitudes given in the table.

A comparison of the two series of corrections, Annual Period — 422 Day Period, shows that for the interval of time which is common to both series of observations (Madison — Berlin, etc.) they are in substantial agreement. Thus for the years 1889–'90, the average difference between the two sets of corrections, taken without regard to algebraic sign is 0″.09, which is but slightly in excess of the difference of the coefficients in the formulæ and leads me to regard the variations observed at Madison as real and not arising from errors in the star places. For the earlier years the discordance between the two sets of corrections is of course large, and it remains to be determined to what extent either one will represent the observed latitudes. For this purpose I have formed the residuals furnished by the latitudes after the periodic corrections have been applied and have entered their values in the columns v', v'' of the table, v' corresponding to the 422 day, and v'' to the 365 day period. Forming the sum of the squares of the residuals there results

$$[v'v'] = 4''.8467 \qquad [v''v''] = 3''.4080$$

It will be observed that since by far the greater part of the observations are included in the years 1888–'89–'90 within which the two sets of corrections differ but little, the excess of $[v'v']$ over $[v''v'']$ is due mainly to the observations of the earlier years and indicates that the 422 day period is far from representing them.

To attempt to draw conclusions in regard to the actual character of these periodic variations from the limited amount of data here discussed does not seem advisable and since the series of observations is of sufficient length to secure a nearly complete elimination of the periodic change I shall apply no corrections for it and adopt the mean value of the latitude given above as a provisional result subject to a minute correction when the actual character of the periodic variation shall have been determined.

CHAPTER III.

LATITUDES BY THE TALCOTT METHOD.

Latitudes have been observed at Madison by the Talcott method in six different years, as follows:

1873. This determination was made by F. Blake, Jr., an officer of the U. S. Coast Survey, and has served as the fundamental latitude for the Coast Survey triangulation in Wisconsin. The observing station was at a point on the University campus 367.5 feet (112.0 meters) south, and 1861.1 feet (567.3 meters) east of the intersection of the axes of the meridian circle of the Washburn Observatory. These distances are derived from two independent and fairly accordant surveys made by the writer in 1879, both of which, however, depend upon the same standards of length, a 50-foot engineer's chain compared with a standard meter bar belonging to the Department of Physics of the University of Wisconsin. From this comparison it appears that the correction to the chain at the temperature at which it was used, 40°±, F., will be taken into account by multiplying the measured distances by 0.999974. This correction has *not* been applied to the distances given above. The C. S. station was again connected with the Observatory in 1885 by an independent survey made by students of the University with results which confirm those given above, although the exact data are not now accessible to me. Adopting the numbers given and transforming them into seconds of arc by mean of the Clark spheroid of 1880 they become

$$\varDelta\varphi = +3''.63 \qquad \varDelta\lambda = +25''.07$$

by means of which the coordinates determined in 1873 are reduced to the meridian circle of the Observatory.

The latitude resulting from the original reduction of these observations is given in the first volume of the Publications of the Washburn Observatory, but this value is now superseded by the results of a rediscussion of the observations made in the Coast and Geodetic Survey office in 1887. The resulting latitude from each pair of stars, kindly communicated to me by the superintendent, Prof. T. C. MENDENHALL, are contained in the following tables. The reduction $+3''.63$ given above has been applied to each result. The adopted declinations of the stars have been derived from a discussion of the data contained in the catalogues cited below, but I have no information concerning the treatment of the authorities or the weights assigned them except the following notes regarding the additional data included in the last revision of the work.

"*Introducing the following improvements in the star places:*

(1.) Additional data consisting chiefly of observations at the Madison Observatory in 1885 the declinations being all reduced to the new Pulkowa standard.

(2.) The use of reductions of other catalogues to the same standard, communicated by Prof. E. S. Holden in a letter dated 10th Dec., 1884.

(3.) A recomputation of proper motions for all stars not fundamental."

I assume that the declinations are reduced to the system of the *Astronomische Gesellschaft*, and I adopt the latitudes unchanged, although I have used slightly different declinations for the same stars in the reduction of subsequent observations.

AUTHORITIES FOR THE DECLINATIONS OF THE STARS.

British Association Catalogue.	Nine Year Catalogue.
Armagh, 1840.	Harvard, 1875.
Twelve Year Catalogue.	Rome.
First Radcliffe.	Harvard, 1885.
Six Year Catalogue.	Madison, 1885.
Seven Year Catalogue.	Armagh, 1875.
Second Radcliffe.	Safford.
Washington.	Boss.
New Seven Year Catalogue.	Astr. Gesell., Earlier.
Glasgow Catalogue.	Astr. Gesell., Later.

The adopted declination of no star depends upon less than five catalogue places and the number is usually from seven to twelve.

1881. This determination was made by G. C. Comstock, at that time an inexperienced observer, with the Fauth transit described in Vol. 1, Publications W. O. The series of observations is an incomplete one and as it was originally regarded as only practice work the observations were reduced with declinations taken from a single authority, Safford's *Catalogue of Mean Declination of 2018 Stars.* The resulting latitude reduced to the position of the meridian circle by the application of the correction — 0."81 is 43° 4′ 36."93. I have revised the declinations employed and have determined new values in accordance with the following principles:

For all stars contained in the Berliner Jahrbuch the position there given is adopted without change For other stars contained in the American Ephemeris the positions there given are reduced to the system of the *Astron. Gesell.* by application of the corrections given in the appendix to the Berliner Jahrbuch for 1881 and are adopted. For all other stars the declinations have been derived from the following sources, in at least two of which every star may be found.

		No. of Stars.
1.	Pulkowa, 3542 Etoiles	2
2.	Bruhns, Gradmessungssterne	2
3.	Respighi, Catalogo. 1875, 1880	21
4.	Rogers, 1213 Stars. 1875	4
5.	Romberg, 5634 Sternen. 1875	3
6.	Becker, 521 Bradley'schen Sternen. 1875	1
7.	Greenwich Ten Year Catalogue. 1880	13
8.	Publications Washburn Obs'y. Vol. IV.	3
9.	Boss, Declinations of Fixed Stars	2

I assume that of these sources 1, 4, 5, 6 and 8 conform to the system of the *Astron. Gesell.* so closely as to require no systematic corrections to their declinations. Systematic corrections to 2 are obtained from Auwers' Fundamental Catalog; to 3 from Respighi's comparison in the Introduction to his catalogue; to 9 from the table in the appendix to the Berliner Jahrbuch for 1881. I have derived systematic corrections to the N. P. Ds. of the Ten Year Catalogue from a comparison of 56 stars which are common to it and the Berliner Jahrbuch between the equator and the pole and included between $17^h\ 30^m$ and 20^h of right ascension. This comparison furnishes the following corrections which I adopt as a sufficiently close approximation for my purpose.

N. P. D.	Corr. to N. P. D.	Romberg.
°	"	"
90	−0.30	−0.23
80	— .30	— .36
70	— .16	— .35
60	— .06	— .04
50	.00	— .05

The quantities given in the column Romberg are interpolated from the table Pulkowa 1875.0 — Greenwich 1880.0 given at p. (17) of the *Supplement III aux Observations de Poulkova*, and are given for the sake of comparison. North of 50° N. P. D., I have found the systematic corrections insensible. In assigning weights to the several authorities I have treated each case independently, but in

general I have considered the several catalogues with the exception of No. 3, as of equal precision. Respighi's declinations have been assigned half weight.

1884. The details of the determination are contained in Publications W. O., Vol. III, but the declinations have been rediscussed in the same manner as those of 1881.

1889. This latitude was observed with the Fauth Transit by Mr. S. D. Townley, at that time a student in the observatory. The instrumental constants were determined, declinations of the stars obtained and the work reduced by Mr. Townley, but the entire discussion has been revised by myself and is strictly homogeneous in principle with that of 1881.

1890. Also observed and reduced by Mr. Townley and revised by myself. In all respects similiar to that of 1889.

1891. This latitude was observed by myself with the purpose of obtaining results which should be directly comparable with those of earlier years. The instrument and observing program are the same as in 1884 and 1890, with the addition of two pairs of stars observed in 1873. The same declinations are used for the reduction of the work of 1884–'90–'91, but as above stated I have allowed the Coast Survey reduction of the 1873 work to remain unchanged. In no case does the difference of declinations adopted in the earlier and later work affect the result from a pair by so much as 0.″05.

In one respect the observing program for 1884–'90–'91 is an unfortunate one. The mean value of the micrometer correction is + 4.0 revolutions of the screw, 1 rev. = 55.″2 approx. The value of a revolution has been determined in each year, and the value thus determined used in the reduction of the observations of the year. In no case does a grouping of the results in the order of magnitude of the micrometer correction indicate any sensible error in the adopted value of a revolution.

The detailed results of the several series of observations are contained in the the following tables whose arrangement is sufficiently indicated by the headings of the columns.

TABLE X. LATITUDE BY TALCOTT METHOD — 1878.

B. A. C. No.	Mag.	R. A.		Dec. 1873.0.			μ'	φ'	Obs.	Star.
		h	m	°	′	″	″	″		
5950	4.7	17	29.7	+55	16	18.34	....			ν Draco pr.
5962	5.8		31.8	30	51	53.15	−0.03	36.20	5	
5990	3.8	17	35.9	46	4	29.57	+ .04			ι Herc.
6062	6.7		47.9	40	0	39.42	....	36.21	5	
6079	3.8	17	51.3	56	53	35.48	....			ξ Draco.
6084	4.0		52.8	29	15	46.16	....	36.36	5	ξ Herc.
6224	5.0	18	13.2	64	21	15.94	....			36 Draco.
6251	4.2		18.3	21	42	48.76	....	36.62	5	109 Herc.
6496	5.7	18	54.6	57	38	49.60	− .07			48 Draco.
6547	5.5		61.6	28	25	48.97	+ .04	36.86	5	
6651	6.7	19	19.5	36	12	6.96	+ .04			
6659	6.6		20.1	50	1	25.77	+ .02	35.89	5	
6687	6.0	19	24.3	52	3	45.00	− .02			
6698	4.6		27.1	34	11	2.20	− .01	36.14	5	8 Cygni.
6741	6.6	19	34.4	48	59	27 95	+ .16			
6771	5.2		39.7	37	2	55.07	....	36.06	5	15 Cygni.
6784	5.2	19	41.6	33	25	59.49	− .45			17 Cygni.
6824	5.2		47.4	52	39	59.49	− .06	36.09	5	20 Cygni.
6895	5.0	19	57.8	49	45	7.35	− .01			e Cygni.
6937	5.3		64.7	36	28	0.28	.00	36.19	5	b³ Cygni.
6983	3.9	20	11.6	47	19	29.70	.00			o² Cygni.
7008	6.8		15.6	39	0	12 80	− .01	36.07	5	
7067	4.3	20	24.2	29	56	45.12	− .01			41 Cygni.
7105	6.0		38.7	56	20	56.20	− .02	36.38	5	

LATITUDE BY TALCOTT METHOD—1881.

B. A. C. No.	Mag.	R. A.	Dec. 1881.0.	μ'	φ'	Obs.	p.	Star.
		h m	° ′ ″	″				
5978	5.6	17 33.8	+61 57 56.80	−0.518				26 Draco.
6005	6.0	38.5	24 22 49.56	+ .088	38.74	1	1.0	84 Herc.
6079	3.8	17 51.5	56 53 29.99	+0.077				ξ Draco.
6084	4.0	53.1	29 15 41.16	— .028	35.99	1	1.1	ξ Herc.
6224	5.0	18 13.2	64 21 25.22	+0.013				36 Draco.
6231	5.4	15.2	21 54 42.28	— .051	37.84	1	1.1	106 Herc.
6251	4.2	18.6	21 42 59.57	— .257				109 Herc.
6421	7.0	18 44.4	49 18 2.61	+0.028				
6456	6.0	49.6	36 49 25.12	+ .001	37.29	2	1.4	11 Lyrae.
6487	4.1	18 54.2	14 54 27.58	—0.080				ε Aquilae.
6510	5.1	55.8	71 8 16.14	+ .031	36.39	1	1.1	υ Draco.
6583	5.4	19 9.4	56 39 24.98	+0.034				53 Draco.
6648	5.2	19.4	29 23 21.78	+ .013	36.82	3	2.4	2 Cygni.
6687	6.0	19 24.5	52 4 42.82	—0.038				
6698	4.6	27.3	34 12 1.64	— .004	35.94	2	1.8	8 Cygni.
6799	5.9	19 43.9	47 36 49.08	—0.042				
6813	5.6	46.3	38 25 0.41	+ .112	35.99	1	0.9	19 Cygni.
6836	3.8	19 48.6	69 57 53.27	+0.016				ε Draco.
6839	5.3	50.6	16 19 14.21	+ .010	36.59	3	2.2	10 Sagittae.
6853	5.6	53.8	16 28 10.84	+ .025				11 Sagittae.
6882	6.2	19 56.7	24 28 15.51	—0.001				
6932	5.3	63.6	61 39 1.09	+ .049	36.39	2	1.8	66 Draco.
6962	5.0	20 9.5	46 27 21.72	+0.01				o^1 Cygni.
6983	3.9	11.8	46 22 51.32	+ .002	35.74	2	2.1	o^2 Cygni.
7022	2.4	17.9	39 52 35.12	+ .019				γ Cygni
7064	6.7	20 23.5	56 14 48.29	+0.00				
7067	4.3	24.5	29 58 19.56	+ .000	38.69	1	1.0	41 Cygni.
....	6.7	20 30.5	72 7 42.30	—0.020				Gr. 3241.
7121	3.8	32.0	14 10 54.96	— .029	36.39	2	2.1	β Delphini.
7188	5.4	20 39.7	24 50 43.66	—0.177				30 Vulpe.
7220	3.6	42.9	61 22 36.60	+ .810	36.94	2	1.9	η Cephei.
7277	4.1	20 52.7	40 42 34.39	+0.001				ν Cygni.
7306	5.4	57.0	45 41 19.85	+ .005	36.79	1	1.0	60 Cygni.

LATITUDE BY TALCOTT METHOD—1884.

B. A. C. No.	Mag.	R. A.	Dec. 1884.0	μ′	φ′	Obs.	p.	Star.
		h m	° ′ ″	″	″			
4843	5.6	14 34.5	+44 54 19.72	−0.056				33 Bootis.
4958	3.0	57.6	40 50 55.02	− .036	36.23	2	3.7	β Bootis.
5036	3.0	15 10.8	33 44 58.54	− 0.105				δ Bootis.
5071	5.6	16.9	52 22 34.39	.000	36.48	6	6.7	
5097	3.0	15 22.3	59 22 22.15	+0.022				ι Draco.
5143	2.0	29.8	27 6 20.55	− .094	37.10	9	12.0	α Coronae bor.
5192	3.8	37.9	26 39 49.23	+ .034				γ Coronae bor.
5302	4.0	15 52.8	27 12 51.87	−0.062				ε Coronae bor.
5348	3.6	59.7	58 52 31.31	+ .345	37.30	9	10.8	ϑ Draco.
5502	5.6	16 21.9	55 28 9.10	−0.012				Gr. 2343.
5541	6.9	29.1	30 44 34.23	− .030	37.03	6	6.7	32 Herculis.
5568	5.7	16 33.0	46 50 55.16	+0.012				
5617	3.1	38.9	39 8 36.62	−0.077	37.64	6	7.4	η Herculis.
5847	4.7	17 13 6	37 24 48.88	+0.084				69 Herculis.
5911	5.7	23.7	48 21 27.85	− .034	37.25	9	8.2	χ Herculis.
6079	3 8	17 51.5	56 53 27.99	+0.077				ξ Draco.
6084	4 0	53.3	29 15 39.29	− .028	36.93	7	9.0	ξ Herculis.
6224	5.0	18 13.2	64 21 28.73	+0.013				36 Draco.
6251	4.2	18.8	21 43 3.70	−0.257	36.44	7	8.1	109 Herculis.
..	6.0	18 35.9	65 23 5.18	+0.027				Gr. 2640.
6387	4.0	40.7	20 26 9.48	− .348	36.78	5	6.7	110 Herculis.
6487	4.1	18 54.4	14 54 41.46	−0.080				ε Aquilae.
6510	5.1	55.8	71 8 30.74	+ .031	37.03	6	7.4	υ Draco.

LATITUDE BY TALCOTT METHOD—1889.

B. A. C. No.	Mag.	R. A.	Dec. 1889.0	μ'	φ'	Obs.	$p.$	Star.
		h m	° ′ ″	″	″			
3059	4.0	8 53.4	+42 13 17.78	−0.258				10 Urs. Maj.
3131	5.0	66.5	43 40 29.33	— .035	37.87	2	0.8	36 Lyncis.
3218	5.4	9 21.4	46 5 14.60	−0.132				41 Lyncis.
3265	4.9	28.1	40 6 49.16	....	36.34	5	1.8	P. IX, 115.
3346	3.6	9 43.1	59 32 37.71	−0.148				υ Urs. Maj.
3371	4.0	46.5	26 31 45.67	— .045	37.39	8	3.0	μ Leonis.
...	6.0	9 48.4	73 24 24.63	−0.041				Gr. 1586.
3459	1.3	62.5	12 30 33.91	+ .018	38.45	5	1.8	α Leonis.
3496	6.0	10 10.0	65 39 41.53	−0.026				32 Urs. Maj.
3523	2.0	13.9	20 21 9.85	— .146	36.85	7	2.5	γ' Leonis.
3593	4.6	10 25.6	76 17 3.85	−0.005				9 H. Draco.
3609	4.0	27.0	9 52 39.29	+ .011	36.34	5	1.9	ρ Leonis.
3647	5.0	10 34.4	66 17 51.33	−0.077				38 Urs. Maj.
3691	5.5	40.4	19 28 35.71	— .036	36.17	3	1.1	m Leonis.
....	6.0	10 51.1	78 21 52.68	−0.026				Br. 1508.
3788	4.8	59.3	7 56 9.54	— .022	37.02	6	2.1	χ Leonis.
3834	2.3	11 8.2	21 7 54.49	−0.115				δ Leonis.
3864	6.1	16.3	64 56 16.09	+ .027	38.59	8	2.8	Gr. 1771.
3915	5.5	11 24.7	19 1 15.59	+0.025				86 Leonis.
3968	5.3	36.3	67 21 33.29	+ .033	37.11	7	2.3	3 Draco.
3979	4.8	11 39.6	8 52 30.10	−0.055				ξ Virginis.
....	5.8	59.6	77 31 35.22	— .114	37.94	4	1.0	Gr. 1852.
3989	5.8	11 42.2	8 51 44.45	+0.024				A' Virginis.
....	5.8	59.6	77 31 35.22	— .114	37.56	6	1.4	Gr. 1852.
4180	5.1	12 18.6	52 10 37.98	+0.012				
4233	5.4	28.2	33 51 38.20	— .06	36.05	6	2.1	
4328	5.0	12 47.8	21 50 55.23	−0.016				
4371	5.8	57.5	64 12 23.31	.00	38.24	5	1.8	
4451	4.6	13 12.6	41 9 25.54	+0.021				
4545	6.0	30.5	44 45 51.45	.00	37.92	7	2.3	20 Can. Ven.

LATITUDE BY TALCOTT METHOD—1890.

B. A. C. No.	Mag.	R. A.		Dec. 1890.0			μ''	φ'	Obs.	$p.$	Star.
				°	'	"					
5036	3.0	15	11.1	+33	43	31.98	−0.017				δ Bootis.
5071	5.6		17.2	52	21	16.76	.000	37.40	3	2.6	
5097	3.0	15	22.5	59	21	5.91	+0.022				ι Draco.
5143	2.0		30.6	27	5	6.70	− .094	37.28	5	5.1	α Coronæ bor.
5193	3.8		38.1	26	38	39.56	+ .034				γ Coronæ bor.
5303	4.0	15	53.0	27	11	48.15	−0.062				ε Coronæ bor.
5348	3.6		59.8	58	51	33.11	+ .344	37.37	6	5.1	ϑ Draco.
5502	5.6	16	23.0	55	27	19.11	−0.012				Gr. 2343.
5541	6.9		29.4	30	43	47.56	− .030	36.84	4	3.0	32 Herculis.
5568	5.7	16	33.3	46	50	10.59	+0.012				
5617	3.1		39.1	39	7	54.49	− .077	36.96	5	3.9	η Herculis.
5847	4.7	17	13.9	37	24	25.27	+0.084				69 Herculis.
5911	5.7		23.8	48	21	8.69	− .031	37.04	5	3.6	χ Herculis.
6079	3.8	17	51.6	56	53	24.03	+0.077				ξ Draco
6084	4.0		53.5	29	15	35.64	− .028	37.11	6	5.1	ξ Herculis.
6224	5.0	18	13.3	64	21	35.74	+0.013				36 Draco.
6251	4.2		19.0	21	43	12.06	− .257	37.34	6	4.6	109 Herculis.
....	6.0	18	35.9	65	23	24.09	+0.027				Gr. 2640.
6387	4.0		40.9	20	26	28.71	− .348	36.99	3	2.6	110 Herculis.
6487	4.1	18	54.6	14	55	9.32	−0.080				ε Aquilæ.
6510	5.1		55.7	71	8	59.92	+ .031	36.96	4	3.6	υ Draco.

LATITUDE BY TALCOTT METHOD—1891.

B. A. C. No.	Mag.	R. A.		Dec. 1891.0			μ'	φ"	Obs.	p.	Star.
				°	'	"					
4843	5.6	14	34.8	+44	52	29.71	−0.056				83 Bootis.
4958	8.0		57.8	40	49	14.53	— .036	37.19	2	2.7	β Bootis.
5036	3.0	15	11.1	33	43	18.40	−0.105				δ Bootis.
5071	5.6		17.2	52	21	3.66	.000	37.07	4	4.7	
5087	3.0	15	22.5	59	20	53.21	+0.022				ι Draco.
5143	2.0		30.1	27	4	54.41	— .094	37.56	6	9.8	α Coronae bor.
5192	3.8		38.2	26	38	27.96	+ .034				γ Coronae bor.
5302	4.0	15	53.1	27	11	37.54	−0.062				ε Coronae bor.
5348	3.6		59.8	58	51	23.42	+ .344	37.46	5	6.4	ϑ Draco.
5502	5.6	16	22.0	55	27	10.79	−0.012				Gr. 2313.
5541	6.9		29.4	30	43	39.73	— .030	36.83	5	4.8	32 Herculis.
5568	5.7	16	33.3	46	50	3.17	+0.012				
5617	3.1		39.2	39	7	47.48	— .077	36.67	4	4.7	η Herculis.
5847	4.7	17	13.9	37	24	21.35	+0.084				69 Herculis.
5911	5.7		23.8	48	21	5.50	— .034	37.72	4	4.2	κ Herculis.
5950	4.7	17	30.0	55	15	31.94	+0.048				ν Draco.
5962	5.8		32.2	30	51	8.98	— .013	37.13	3	3.7	
5990	3.8	17	36.4	46	3	52.10	−0.002				ι Herculis.
6062	6.7		48.4	40	0	21.88	+ .062	37.51	3	3.7	
6079	3.8	17	51.6	56	53	23.37	+0.077				ξ Draco
6084	4.0		53.5	29	15	35.04	— .028	37.19	3	4.1	ξ Herculis.
6224	5.0	18	13.3	64	21	36.91	+0.013				36 Draco.
6251	4.2		19.1	21	43	13.47	— .257	36.84	2	2.7	109 Herculis.
....	6.0	18	35.9	65	23	27.25	+0.027				Gr. 2640.
6387	4.0		41.0	20	26	31.93	— .348	36.82	3	3.7	110 Herculis.

TABLE XI.—LATITUDES BY TALCOTT METHOD.

SUMMARY OF RESULTS.

Date.	Obsr.	No. of Pairs.	No. of Obs.	$r(\zeta)$	φ	$r(\varphi)$	Remarks.
1873 Aug	B.	12	60	$\pm0''.34$	$36''.26$	$\pm0''.05$	
81 Aug. 20	C.	15	25	.50	36 .69	.14	
84 July 3......	H. & C.	11	72	....	36 .98	.07	±0.52 H. $\pm0.''33$ C.
89 May 2	T.	15	84	.78	37 .36	.14	
90 July 1......	T.	10	47	.50	37 .15	.04	
91 July 4......	C.	12	44	.40	37 .21	.06	

The several columns in the above summary seem to require no explanation other than the statement that $r(\zeta)$ denotes the probable error of a single observation when the declinations are eliminated and $r(\varphi)$ denotes the probable error of the adopted latitude computed from the residuals furnished by the mean result from each pair. The value of $r(\zeta)$ for the two observers who took part in the 1884 work are given separately in the column of remarks.

The values of the latitude thus obtained are affected with whatever periodic variation may exist in the position of the pole, and since the law of this inequality has not been definitely determined up to the present time (Dec. 1891), I have made four hypotheses in regard to it, as follows:

(a.) *That there is no sensible variation.*

(b.) *That the variation follows the law given by Chandler* (*A. J. No.* 249)
$\varphi = \varphi_0 - 0''.28 \cos[\lambda + (t - T)\vartheta]$ $T = 2\ 402\ 888$ $\vartheta = 360^\circ / 427$. *Green'ch* λ

(c.) *That it follows the law derived at p.* 126 *from the Berlin, Potsdam, Prag observations*
$\varphi = \varphi_0 - 0''.25 \cos[\lambda + (t - T)\vartheta]$ $T = 2\ 411\ 406$ $\vartheta = 360^\circ / 422$. *Berlin* λ

d.) *That it follows the law derived from the Madison observations* $\varphi = \varphi_{\text{t}} + 0''.32\ (\tau - 0.164)\ 360^\circ$

The corrections and the corrected values of the latitude corresponding to the several hypotheses are shown in the following table:

TABLE XII.

Epoch.	Corrections.			Corrected Latitudes.				Latitude 1890.0.
	b	*c*	*d*	*a*	*b*	*c*	*d*	
	"	"	"	"	"	"	"	"
1873.62	−0.18	+0.25	+0.31	36.26	36.08	36.51	36.57	37.31
81.63	+ .13	+ .24	+ .31	36.69	36.82	36.93	37.00	37.38
84.50	− .07	− .23	+ .17	36.98	36.91	36.75	37.15	37.40
89.33	+ .12	− .18	+ .16	37.36	37.48	37.18	37.20	37.23
90.50	+ .11	− .16	+ .15	37.15	37.26	36.99	37.30	37.28
91.50	− .09	− .25	+ .17	37.21	37.12	36.96	37.38	37.31

These numbers indicate that none of the hypotheses will suffice to reconcile the observed values of the latitude but all agree in showing a more or less regular increase amounting to nearly a second of arc between 1873 and 1891. From the values of the latitude obtained on hypothesis (*d*), the most regular series, I derive the following expression

$$\varphi = 43^\circ\ 4'\ 37.''32 + 0.''045\ (t - 1890.0)$$
$$\pm\ 0.''017 \qquad \pm\ 0.''0022$$

The observed values of the latitude reduced to 1890 by means of the annual variation above given are contained in the last column of the table.

By the introduction of the term depending upon t the $[pvv]$ is reduced from 0.″4518 to 0.″0033. The probable errors given above represent the internal agreement of the data from which the results are derived but have little physical significance since the data itself is subject to considerable uncertainties arising from the unknown character of the short period variations of the latitude but it appears impossible to frame any reasonable hypothesis in regard to these variations which will suffice to represent the data without the introduction of a secular term.

The conclusion that the apparent change of latitude denoted by these results is real, is open to one objection more serious in appearance than I conceive it to be in reality, viz.: that the results for the several years are derived in great measure from different sets of stars, the errors in whose assumed declinations may produce the difference in the resulting latitudes. The character of the star places employed, the fact that they are derived mainly from observations

contemporaneous with the series of latitude determinations in question and the great regularity in the change of latitude are all unfavorable to this hypothesis, but still more cogent evidence against it may be found in the following tabulation of results derived from the same pairs of stars observed in different years.

TABLE XIII.

Stars.	φ, 1873.	φ, 1891.	Diff.
	″	″	″
ν Draconis .... B. A. C. 5962..........	36.17 ±0.15	37.13 ±0.23	+0.96 ±0.27
ι Herculis.... .... B. A. C. 6062..........	36.19 ±0.15	37.51 ±0.23	+1.32 ±0.27
ξ Draconis .... ξ Herculis	36.40 ±0.15	37.19 ±0.23	+0.79 ±0.27
36 Draconis............ 109 Herculis..	36.58 ±0.15	36.84 ±0.28	+0.26 ±0.32

In the formation of this table the Coast Survey values of the 1873 latitude have been corrected by the introduction of the declinations used in reducing the observations of 1891 so that the results here compared are referred to a homogeneous set of declinations and the variation of the latitude which is indicated by these results cannot be attributed to errors in the assumed declinations. Combining the results from the four pairs there is obtained

$$\text{Annual Variation of } \varphi = +\ 0''.046$$

in excellent agreement with the result furnished by all of the data, although no correction for periodic variation has been applied to the latitudes.

I therefore adopt as the definitive result of all the latitude determinations by the Talcott method made at Madison prior to 1891, the result given above

$$\varphi_0 = 43^\circ\ 4'\ 37''.32 + 0''.045\,(t-1890)$$

which refers to the intersection of the axes of the meridian circle, and is still subject to correction for the effect of short period variations in the latitude.

CHAPTER IV.

MISCELLANEOUS DETERMINATIONS OF LATITUDE.

(A.) From Transits over the Prime Vertical. Observer G. C. Comstock.

Vol. III, Publications of the Washburn Observatory, contains the details of a latitude determination made by this method in 1884, using the Fauth transit. I adopt as definite the results there published for all the stars whose positions are given in the *Fundamental Catalog* of the *Astronomische Gesellschaft*. In the original reduction of the work the places of the remaining stars, six in number, were taken from Boss' Catalogue and reduced to the system of the *Astronomische Gesellschaft* by the application of the systematic corrections contained in the appendix to the *Berliner Jahrbuch* for 1884. These latter declinations I have revised in the manner explained in connection with the derivation of declinations for the zenith telescope latitudes, except that in addition to the catalogues there cited I have made use of the results contained in the Greenwich annual volumes for 1887 and 1888, assuming that these declinations, as well as those of the Ten Year Catalogue, may be reduced to the A. G. system by means of the relation between Greenwich and Pulkowa 1875, contained in the introduction to Romberg's Catalogue. Each of the six stars subject to revision is contained in at least three of the catalogues, and from 25 residuals furnished by these stars I obtain as the probable error of a catalogue place of unit weight ±0″.35 from which the probable errors of the finally adopted declinations have been computed. These probable errors are employed in deriving the weights to be assigned to the mean results from the several stars observed, by means of the formula.

$$p = \frac{m}{k \left\{ r(\delta_1)^2 + r(\delta_2)^2 \right\} + \frac{0.36}{n}}$$

derived at pp. 37, 38, of Vol. III, Publications W. O.

The mean results from the individual stars are given in the following table in which μ' and $r(\delta)$ denote the proper motion and assumed probable error of the declination of the star and n is the number of nights on which it was observed. The stars to whose names the letter C is appended are included in the discussion of declinations above referred to. All other declinations and proper motions together with the right ascensions of the six stars observed in pairs, one over the east, the other over the west vertical, have been taken directly from the *Berliner Jahrbuch*.

TABLE XIV.—PRIME VERTICAL LATITUDE.

Star.	Dec 1884.0.	$r(\delta)$	μ'	φ	n	p
	° ′ ″	″	″	″		
Boss 449 ......C.	42 15 15.83	±0.16	+0.033	35.49	2	0
Gr. 2533.........	42 7 13.30	.20	+ .004	36.84	4	6
ν Cygni....	40 43 15.58	.12	+ .001	37.15	9	14
Boss 376.... ..C.	40 18 17.86	.14	— .036	36.79	7	10
Boss 358.......C.	40 8 49.14	.16	+ .009	36.00	4	7
Gr. 2415 W.. ..	40 40 5.49	.25	— .014			
74 Cygni E... ..	39 53 33.35	.24	+ .009	37.19	9	6
γ Cygni...........	39 58 9.26	.09	+ .019	36.99	8	16
σ Cygni........ C.	38 54 31.66	.09	— .012	37.08	8	9
α Lyrae W......	38 40 34.81	.06	+ .295			
10 Lacertae E......	38 26 48.22	.15	.000	36.58	9	15
Boss 414.......C.	38 11 56.94	.13	— .020	36.55	8	7
40 Cygni.... ....C.	38 3 35.03	.10	— .066	37.05	4	10
9 Herc. W........	37 15 59.32	.23	+ .019			
τ Cygni E.... ...	37 33 2.37	.14	+ .460	37.30	7	8

The star Boss 449 was on each night observed at its transit over one vertical only, and has therefore been given weight 0. Combining the results from the other stars by weight we obtain as the latitude of the meridian circle

$$\varphi = 43° \, 4' \, 36''.88 \pm 0''.07$$

which is still subject to a correction for periodic variation of the latitude, the argument for which is the mean date of the observations, 1884, Aug. 24. The most probable value of this correction seems at present to be that furnished by the formula

$$\varphi = \varphi_0 + 0''.32 \cos(\tau - 0.164) \, 360°$$

derived from contemporaneous meridian circle work, and used in connection with the latitudes by the Talcott method. This correction is $\Delta\varphi = + 0''.32$ giving as the provisionally adopted value of the latitude of the meridian circle derived from the 1884 transits over the prime vertical $43° \, 4' \, 37''.0$, which is in excellent agreement with the latitude by the Talcott method determined in the same year.

B. Latitude by Zenith Distances (Universal Instrument).

In the winter of 1891–'92 I made a short series of latitude determinations with a small universal instrument by Bamberg, more with a view of testing the capabilities of the instrument than of contributing to a knowledge of the latitude; but the results obtained seem worthy to be included in the present discussion.

A cut of the instrument. together with a brief description, may be found in Jordan's *Grundzüge der Astronomischen Zeit—und Ortsbestimmung, p. 44*; but the dimensions and constants of the instrument are somewhat different from those there given. The broken telescope has a clear aperature of 35.5 *mm*, and a focal length of 373 *mm*. It is provided with two eye-pieces the shorter of which, furnishing a power of 36 diameters, has been exclusively employed. The horizontal circle has a diameter of 173 *mm*., and the vertical circle 165 *mm*. Each circle is divided to 10′ and read by two micrometer microscopes to 10″, or by estimation to single seconds. The microscope heads give by direct reading double seconds, and nominally read to 5″ instead of 10″. The radius of curvature of the striding level is 98.06 meters; of the microscope level 95.15 meters. The adopted values of a division of these levels are 4.″70 and 4.″88 respectively.

I have removed from the telescope the system of spider threads provided by the maker, and have substituted for them a ruled glass plate, having one horizontal and nine vertical lines, which are as sharp and distinct as any spider threads I have ever seen, and have the advantage of being much finer. The instrument is in every way a thoroughly excellent one. For a discussion of its efficiency in time determinations reference may be made to the *Sidereal Messenger, No. 98.*

The observing program for a latitude determination required the observation of Polaris and two southern stars in six symmetrically disposed positions of the vertical circle. On each of the six nights required by this program it was in intended to measure 12 zenith distances of Polaris (24 pointings) and six of each of the southern stars a different pair of southern stars being observed on each night. This program has been adhered to in substance although the number of observations has been occasionally in excess or defect of the program. In the details of the observing I have followed the instructions prepared by Albrecht for the observers of the *K. Preussiche Geodätische Institut.*

The southern stars have been selected from the Mittlere Oerter von 303 Sternen given as an appendix to the Berliner Jahrbuch for 1891 and 1892 or from the B. J. itself. In the latter case (only ν Piscium) they have been reduced to the system of the 303 Stars by application of the correction + 0.″50 — 0.″025°.

There are included in this determination 89 zenith distances of 15 southern stars and 77 zenith distances of Polaris observed on seven nights. From the observations of the southern stars I find as the probable error of a single zenith distance, one pointing Circle R and Circle L., $r = \pm 0.''55$ and from the

Polaris observations $r = \pm 0.''56$ which denotes a degree of precision quite unexpected at the beginning of the work but probably does not represent the best attainable with the instrument since the major part of the observations were made with artificial illumination instead of by twilight and under circumstances involving considerable personal discomfort to the observer.

A summary of the latitudes furnished by each star is contained in the following table in which the column of Zenith Points indicates the position of the circle on each night and the quantity z is the meridian zenith distance of the star.

TABLE XV.—LATITUDES FROM SOUTHERN STARS.

Date 1891-'92.	Zenith Pt.	Star.	z.	φ'	Remarks.
	° ′		° ′	″	
Dec. 28	179 54	δ Ceti..	43 13	37.78	
		o' Eridani	50 12	37.67	
27	149 22	ϑ Ceti	51 49	37.02	Incomplete obs. ½ wt.
		ξ Piscium	40 [illegible]5	37.76	
		ν Eridani	46 39	36.94	
29	110 7	ν Piscium	38 8	36.72	
		ρ Ceti	55 51	38.29	
Jan. 23	89 5	o Piscium	34 28	34.10	
		σ Ceti	58 48	37.94	
28	62 40	μ Eridani	46 33	38.18	
		ε Orionis	44 21	37.94	
29	31 40	β Eridani	48 18	38.27	
		ι Orionis	49 8	39.09	
Feb 13	31 40	α Can. Maj	59 39	37.10	Through clouds.
		α Can. Min.	37 35	38.59	Through clouds.

For the anomalous value of the latitude furnished by o Piscium on Jan. 23 I have no explanation to offer. The circumstances attending the observations were all favorable save that the level corrections were large, and the individual zenith distances are in excellent accord. The large values of the latitude obtained on Jan. 29 led me to suspect some systematic error in the night's work and another determination in the same position of the circle was made on Feb. 13 through moderately thin stratus clouds. In no case did the hour angle of a

southern star exceed 20m. at the time of observations and in only a few instances was it greater than 15m.

The result of each night's observing is shown in the following table:

TABLE XVI.—LATITUDE BY THE UNIVERSAL INSTRUMENT.

Date, 1891–'92.	Latitude from		Polaris.		N.—S.	φ'	Remarks.
	Polaris.	Southern Stars.	Δt	$\Delta\delta$			
	"	"	"	"	"	"	
Dec. 23	36.44	37.72	+0.16	+0.88	−1.28	37.08	
27	37.58	37.28	+ .19	.82	+0.30	37.43	
29	37.08	37.50	− .08	.97	−0.42	37.29	
Jan. 23	38.36	36.02	+ .10	.94	+2.34	37.19	
28	36.71	38.06	+ .26	.65	−1.35	37.38	
29	38.83	38.68	+ .30	.45	+0.15	38.76	
Feb. 13	38.74	37.84	+ .34	+ .05	+0.90	38.29	Thro' clouds. Faint.

The quantities in the colums Polaris, Δt and $\Delta\delta$, are respectively the increments of the latitude which would be produced by increasing the adopted hour angle and declination of the star by one second of time and one second of arc. The column *N.—S.* shows the excess of the latitude derived from Polaris over that furnished by southern stars. The observations having been reduced with an assumed flexure constant of $+1''.0$ the mean value of $N.-S.=+0''.02$ indicates that this constant requires no sensible correction. The regular alternation of signs in the values of *N.—S.* may be due to accident or may be considered as indicating a periodic error of graduation of the circle depending upon six times the zenith distance. The observations are not well adapted to determining the coefficient of the term depending upon $4z$.

The quantity $\varphi'=\frac{1}{2}(N.+S.)$ represents the latitude result furnished by the observations of each night and is still subject to correction for periodic variation of the latitude. Since the results for January 29 and February 13 were obtained in the same position of the circle I adopt their mean as a single determination of the latitude and giving to each of the other determinations equal weight with this mean obtain $37''.48$ as the seconds of latitude. For all of these observations the instrument was mounted in the stone portico at the east entrance to the observatory at a point 19 feet north of the meridian circle whence the resulting latitude of this instrument is

$$43^\circ\ 4'\ 37''.29 \pm 0''.06$$

The probable error is derived from the value of the p. e. of a single zenith distance = ± 0″.55 and the assumed probable errors of the declinations ± 0″.15 for southern stars and ± 0″.04 for Polaris. Accidental error of graduation and other sources of error difficult to evaluate ought doubtless to be included with the above, and I estimate that ± 0″.10 will more nearly correspond to the real value of the probable error than the ± 0″.06 which results from the consideration of known sources only.

CHAPTER V.

SUMMARY.

We have now to collate the several latitude determinations at Madison and to inquire their relation one to another. Classifying them by methods we have:

Meridian Circle. Absolute Latitude.

	° ′ ″	″	
1885.0	43 4 36.95	± 0.06	$\Delta\varphi = 0.26 \sin (L+62°)$
89.1	36.72	± .04	Uncorrected.

Meridian Circle. Relative Latitude.

	° ′ ″	″	
1884.0	43 4 36.79	± 0.06	Uncorrected.
85.0	36.73	.04	"
86.0	36.77	.06	"
87.0	36.84	.03	"
88.0	36.92	.05	"
89.0	36.92	.03	"
90 0	36.90	.03	"

Talcott Method.

	° ′ ″	″	
1873.62	43 4 36.08	± 0.05	Chandler 427 day period.
81.63	36.83	.14	" " " "
84.50	37.15	.07	$\Delta\varphi = 0.32 \cos (\tau - 0.164)\, 360°$.
89.33	37.20	.14	" " " "
90.50	37.30	.04	" " " "
91.50	37.38	.06	" " " "

Prime Vertical Transits.

	° ′ ″	″	
1884.64	43 4 37.10	± 0.07	$\Delta\varphi = 0.32 \cos (\tau - 0.164)\, 360°$.

Zenith Distances. Universal Instrument.

	° ′ ″	″	
1892.03	43 4 37.29	± 0.10	Uncorrected.

In this tabulation of results I have neglected the effect of periodic variation of the latitude wherever the observations extend over a sufficient period of time to substantially eliminate this effect, and have also omitted it from the 1892 determination since no data are at present available for determining the necessary correction. Wherever corrections have been introduced their nature is indicated in the table and in explanation of the corrections it should be said that the values of $\Delta\varphi$ from 1884 to 1891 inclusive, are derived from the contemporaneous meridian circle observations. It has not appeared to me legitimate to extrapolate these corrections, and I have therefore employed for the latitudes of 1873 and 1881 Chandler's 427 day period. All of these corrections must be considered as rather uncertain and the probable errors assigned to the several determinations do not include this element, but relate solely to the accidental errors of the observations, and in the case of the absolute latitudes to uncertainties in the determination of the refraction and instrumental constants.

The apparent indication of an increasing latitude presented by the second and third methods are very striking, but this indication seems flatly contradicted by the absolute latitudes which show a diminution of the latitude amounting to nearly a quarter of a second in four years. Whether the latitude be considered as subject to secular change or as constant this difference amounting to four times the probable errors of the determinations is certainly noteworthy and indicates systematic error inherent in one or both determinations. Personal differences in the observers seem hardly adequate to explain so large a difference but may account for a portion of it. The surroundings of the instrument and the circumstances under which the observations of 1885 and 1889 were made were entirely similar with one exception which deserves to be noted as it may afford a clue to the systematic errors.

Between the ceiling and the roof of the meridian circle room is an attic eleven feet high at the ridge and five feet at the eaves. This attic is separated from the slit by wire netting which permitted a free circulation of air at the time the observations of 1885 were made. Prof. Brown considered this circulation objectionable and at an early period in his work had the sides of the slit ceiled up with heavy manilla paper effectually cutting off the circulation. That the changed conditions thus produced in the observing slit should systematically change the course of a ray of light in passing through the slit is not improbable although it would be difficult if not impossible to trace the effects in detail.

That such an effect was actually produced seems indicated by the relative latitudes observed by Prof. Brown. I can find no record of the exact date at which the paper was introduced into the slit but the recollection of members of the observatory staff fixes it at some time during the summer of 1888. Some indication of its effect may therefore be obtained by comparing the latitudes determined by Prof. Brown prior to the summer of 1888, with those obtained by him in corresponding months of the following year. The stars observed at

these epochs are nearly the same, and any error in the assumed periodic variation of the latitude will be in great part eliminated. Such a comparison is contained in the following table, the individual values being themselves mean results taken fron Table VII, p. 113, and corrected for periodic variations by the formula.

$$\Delta \varphi = 0.''32 \cos (\tau - 0.164)\, 360^\circ$$

EFFECT OF CLOSING SIDES OF TRANSIT SLIT.

WITHOUT PAPER.		WITH PAPER.	
Epoch.	φ_0''	Epoch.	φ_0''
	"		
1887 Nov. 11	37.15	1888 Nov. 9	37.03
Dec. 21	37.30	Dec. 21	37.14
'88 May 20	37.08	'89 May 23	37.07
June 8	37.13	June 17	36.92
Mean....	37.16	Mean ...	37.04

The data is here insufficint to justify positive conclusions but there seems to be a real dimunition of the latitude of rather more than 0.″1. From a comparison of 24 stars within 20° of the pole which were observed 13? times before, and 14? times after introducing the paper into the slit I find a diminution of 0.″16 in the latitude between the two epochs which are separated by an average internal of nine months.

These differences are not greater than exist in several series of observations made with other instruments and they appear to me insufficient to decide whether closing the side of the slit has or has not produced a sensible effect.

It does not appear feasible to draw determinate conclusions from the data above discussed with reference to a secular variation of the latitude. The evidence furnished by the meridian circle is conflicting, and is not in any case entitled to much weight on account of the short interval of time covered by the observations. The evidence furnished by the Talcott latitudes is more consistent and more cogent.

Whether such variations are to be regarded as local phenomena or as more widely manifested seems worthy of serious study. Further investigation will also be required to determine whether the variations are of a uniformly progressive character or subject to irregular fluctuations such as seem indicated

by some excellent series of observations, notably those at Bethlehem and Cordoba and the early Dorpat observations.

It is my purpose to continue the latitude determinations at Madison as a contribution to the solution of these problems, but such investigations conducted at a single observatory are not well adapted to the desired end, and a systematic campaign along the lines suggested by Fergola, in 1884, is much to be desired.

In the meantime it seems to me proper to adopt for the reduction of the meridian circle observations of 1883–'87 the absolute latitude above derived for the epoch 1885.0, and for the observations of 1888–'90 to employ the value furnished by these observations for the epoch 1889.1, and to regard these mean values as subject to periodic changes only.

END OF VOL. VI.